The Efficacy of Mobile Mental Health Applications (mHealth apps) in Reducing Symptoms of Anxious and Depressive Distress in a University Population

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Abstract

Internet-based self-help interventions, such as mobile mental health applications (mHealth apps), have the potential to enhance mental health service delivery in universities in a cost-effective way. However, the existing literature on mHealth apps is limited and does not sufficiently support their supposed benefits. The present study attempted to evaluate the efficacy of self-guided mHealth apps in reducing symptoms of psychological anxious distress and psychological depressive distress among university students. Students (N = 77; 76.6% female; 17 to 53 years old) completed the Hospital and Anxiety Depression Scale (HADS) prior to being randomized to 6 weeks of intervention with one of three mHealth apps marketed for reducing anxiety (DARE, Mindshift, or Stresscoach), or an active smartphone-based control to rule out the digital placebo effect (Coloring Book for Adults app). After 6 weeks, students completed the HADS again as a follow-up measure of app effectiveness. The results did not support the effectiveness of the mHealth apps in reducing anxious or depressive distress (Pillai's Trace = .024, F(6, 146) = .290, p = .941). However, the results suggested that over time, students' levels of depression increased, irrespective of app (mean difference = -.698; 95% CI = -1.364 to -0.33). The results also suggested that students with problematic levels of anxious distress at baseline experienced a decrease in symptoms at follow-up, irrespective of app (mean difference = 1.696; 95% CI = .816 to 2.575). Conversely, students who did not report anxious distress at baseline experienced an increase in anxious distress at follow-up, regardless of app (mean difference = -1.806; 95% CI = -2.878 to -.735).

Keywords: mHealth apps, anxiety, depression, university students, active smartphone-based control, digital placebo, randomized controlled trial (RCT), repeated measures MANOVA

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Emerging adulthood is a distinct developmental period that straddles the stages of adolescence and young adulthood (Arnett, 2000; Auerbach et al., 2018). It refers to those in the 18- to 24-year-old range and is characterized by increased independence from parents (e.g., leaving the home), significant shifts in social roles, and relational instability (Auerbach et al., 2018). This developmental stage represents a time of profound change and importance (Arnett, 2000), and while this can be an exciting time, it can also be a time fraught with uncertainty, experimentation, and risk taking.

Emerging adults have been found to fare worse than the general population on measures of psychological well-being (Cooke et al., 2006; Sharp & Theiler, 2018). They have also been found to have the highest prevalence of mental disorders compared to any other age group, with psychological anxious distress and psychological depressive distress being among the most prevalent (Adlaf et al, 2001; Ontario University & College Health Association [OUCHA], 2017; Robinson et al., 2016; Sharp & Theiler, 2018; Youth Mental Health Stats in Canada, 2019). This age range encompasses the majority of university students with 46% of Canada's emerging adults (Statistics Canada, n.d.), and 42.1% of America's emerging adults participating in postsecondary education (Education Data Initiative, 2022). A preponderance of research evidence suggests that university students all over the world have a higher prevalence of mental health issues than their non-university counterparts (Adlaf et al., 2001; Bayram & Bilgel, 2008; OUCHA, 2017; Robinson et al., 2016; Sharp & Theiler, 2018; Stallman, 2010). This prevalence rate is significant not only for the psychological distress experienced during a period of major life transition, but also for the academic impairments that can result (Auerbach, et al. 2018).

Of further concern, research suggests that prevalence rates among university students have been on the rise in recent years (Räsänen et al., 2016; Sharp & Theiler, 2018; Storrie et al., 2010), though estimates tend to vary from study to study. As a result of this reported increase, some university counselling centers have identified difficulties meeting the needs of students with significant psychological distress (Lipson et al., 2019). Despite high prevalence rates, multiple studies have found barriers to help-seeking in student populations (Hunt & Eisenberg, 2010) resulting in missed opportunities for much needed mental health support during an important developmental period. Given today's technological environment in which smart phones and other devices have essentially become bodily appendages, particularly among young adults, technology could serve as a mechanism to address, and potentially alleviate, some of these barriers.

Computer-delivered and Internet-enabled mental health interventions have been saturating the mental health landscape in recent years (Heber et al., 2017). Programming technology enables these types of interventions to be delivered through a range of multimedia formats using interactive features designed to engage users and facilitate intervention efficacy (Davies, et al., 2014). Of particular interest are mobile mental health applications (mHealth apps) which have flooded the mobile app market (Torous & Firth, 2016). Given the ease with which these apps can be accessed, they have the potential to enhance mental health service delivery to university students who might not otherwise pursue traditional interventions. Unfortunately, the existing literature on mHealth apps is limited and does not sufficiently support their supposed benefits (Van Ameringen et al., 2017). mHealth app development has severely outpaced app research, and for apps to achieve the level of efficacy expected more resources must be put toward researching existing apps for their intended uses (Van Ameringen et al., 2017).

The aim of the present study was to contribute to the growing literature regarding self-guided mHealth apps by evaluating the efficacy of these apps in reducing psychological distress in university students. Specifically, this study focused on evaluating the efficacy of mHealth apps marketed for alleviating psychological distress associated with anxiety. Furthermore, since anxiety and depression tend to be the most common symptoms reported by university students (Adlaf et al, 2001), and since they tend to co-occur (Bakker et al., 2016), the ability of these apps to reduce symptoms of psychological distress associated with depression was also explored.

This paper begins with a general overview of the mental health challenges faced by university students, followed by a specific exploration of the experience of psychological anxious distress and psychological depressive distress in this population. A review of internet based mental health interventions follows, in which the potential value of this form of intervention is considered within the context of a university population. The rationale and hypotheses are then presented.

The results for self-identified symptoms of psychological anxious distress and psychological depressive distress among the sample of undergraduate students are discussed in terms of app effectiveness. The findings are compared to the present literature, and conclusions about the efficacy of self-guided mHealth apps among student populations are made based on the strengths and limitations of the current study.

Mental Health Challenges in University Students

While university life offers new and exciting opportunities for freedom, self-discovery, and social experiences, it can be a difficult time of adjustment and adaptation. This adjustment can be a significant stressor in a young person's life as academic demands increase and new social relationships are established (Friedlander et al., 2007). The university years are widely

considered to be the most stressful time in a person's life (Bland et al., 2012) and studies have shown that anxiety, depression, and anger are the most prominent symptoms of psychological distress reported by students, followed by somatic and obsessive-compulsive symptoms (Sharp & Theiler, 2018). The stress of university can put a strain on students' psychological functioning, regardless of prior functioning (Sharp & Theiler, 2018).

In 1987, Fisher and Hood conducted research with students at a UK university using the Middlesex Hospital Questionnaire. They assessed psychological symptoms two months prior to the start of university, and again six weeks into the term. Students' scores showed significant increases in depression and obsessional symptoms by week six, and all students showed evidence of increased psychological distress. Similarly, Andrews and Wilding (2004) used the Hospital Anxiety and Depression Scale (HADS) to assess levels of psychological distress among first year students at a UK university one month before classes began, and again during the middle of their second year. They found that by year two, 20% of students who were symptom-free prior to starting university had developed anxiety, while 9% had developed depression. Cooke and colleagues (2006) collected information about the psychological states of first year students at a UK university using the General Population Clinical Outcomes in Routine Evaluation (GP-CORE) survey. They discovered that psychological distress, particularly anxiety, increased after students began their studies, and while it decreased somewhat later in the first year, it did not return to pre-university levels. This pattern was found to be consistent for students whose overall psychological wellbeing was considered normal as well as those considered at risk.

Pritchard and colleagues (2007) assessed the psychological states of first-year students at an American university before the start of classes using the Inventory of College Student Recent Life Experiences and the Profile of Mood States. They found that students' negative affect (a

combination of anxiety, tension, depression, anger, confusion, fatigue, and lack of vigour) was more prevalent at the end of their first year than it had been before classes began. In a study conducted by Zivin and colleagues (2009), 24% of American university students who did not have a mental health problem prior to starting classes had developed one two years later. The highest prevalence for newly developed mental health issues was for depression, eating disorders, and self-injury. Bewick and colleagues (2010) utilized the GP-GORE with students at a UK university and found a worsening of psychological distress across three years of postsecondary study, with scores in the third year showing a 100% increase compared to pre-registration. In general, anxiety levels peaked during the first semester of each year. Depression scores were found to be significantly lower than anxiety scores across the three years, although depression increased slightly but steadily over time. In line with the findings of Andrews and Wilding (2004) and Cooke et al. (2006), the results of this study suggest that university is predominantly an anxiety-provoking, rather than a depressive time for students.

While the stress of university life may trigger the onset of psychological problems for some students, this stress can exacerbate or cause a relapse of pre-existing emotional and psychological problems in others (Pedrelli et al., 2015; Royal College of Psychiatrists, 2003). This is particularly concerning given that roughly half of all life-time mental disorders start by the mid-teens, while 75% start by the mid-twenties (Kessler et al., 2007). Of further concern, the persistence of pre-existing mental disorders is reported to be very high among postsecondary populations (Auerbach et al., 2018) and may even worsen over the course of study (McLafferty et al., 2017).

Auerbach and colleagues (2016) used the WHO World Mental Health Survey to examine the mental health of university students across 21 countries. Of the 20% of students who met

criteria for a 12-month DSM-IV disorder, 83% reported the onset prior to starting university. The authors found that disorders with pre-enrollment onset were more important than those with post-enrollment onset in predicting subsequent student attrition, substance disorders, and major depression. In Andrews and Wilding's (2004) study of UK university students, it was found that students with clinically significant pre-entry levels of anxiety were more likely to be depressed by their second year of studies compared to those who did not report having anxiety (26% vs. 9%).

In Zivin and colleagues' (2009) research with American university students, a baseline survey was completed prior to starting classes, and again two years later. At baseline, the researchers found that more than a third of students (35.3%) suffered from at least one mental health problem. Two years later, 60% of those students still had at least one mental health problem. At both study times, the highest prevalence was for depression (13-15%) and eating disorders (18-19%). Interestingly, the prevalence of anxiety was found to be low at both study times (4-7%). Storrie and colleagues (2010) conducted a systematic review of the literature on mental health problems among university students worldwide. They found that 51% of students experiencing mental illness had their onset prior to starting university, while the remaining students reported the onset during university. The most common problems included anxiety, depression, psychotic disorders, eating disorders, self-harm, and obsessive-compulsive disorder.

The high prevalence of pre-existing mental health issues among university students suggests that the postsecondary experience may not be a primary cause of psychological distress among this population. Rather, the typical age range of university students seems to be a more important predictor of mental health in this population. This would make sense given that the 18- to 24-year-old age range represents a peak onset period for the occurrence of mental health

issues (Auerbach et al., 2018; Ibrahim et al., 2013). Further supporting this point, mental disorders account for about half of the disease burden of all young adults in developed countries (Harrer et al., 2019), not just those attending university.

It is important to note that much of the research on student mental health fails to use community samples or non-university attending comparison groups (Blanco et al., 2008). Consequently, the frequently reported finding that university students experience mental health issues to a greater extent than their non-university counterparts may be inaccurate. This finding may more accurately reflect an imbalance in the populations studied rather than an actual difference in prevalence rates. This imbalance makes sense given that university students are a more easily accessible, convenient, and willing population to study than their non-university counterparts. The problem inherent in this imbalance is that convenience samples can threaten validity, misrepresent prevalence rates, and contribute to the appearance of crises in certain groups (Wiens, et al., 2020).

As a result of these concerns, Wiens and colleagues (2020) compared the mental health of postsecondary students in Canada to their non-university counterparts from 2011 to 2017 using the Canadian Community Health Survey. The findings suggested that most mental health outcomes were lower for postsecondary students than non-students. The authors proposed that the perception of worse mental health among postsecondary students may result from better recognition of mental disorders and/or different levels of help-seeking behaviour among this population, particularly among females. Furthermore, additional research by Blanco and colleagues (2008) suggested that the odds of any psychiatric disorder having occurred over a 12-month period were similar for postsecondary students and non-students alike, with almost half of the young adults in both populations meeting DSM-IV criteria for at least one psychiatric

disorder in the preceding 12 months. The most common disorders found among both groups were personality disorders, although mood and anxiety disorders were also found to be high.

In Auerbach and colleagues' (2016) research using the WHO World Mental Health Survey data, they compared the mental health of postsecondary students to nonstudents in the same age range (18-22). Students were found to have a lower mean number of overall disorders (23.9%) than non-students (32.8%). Anxiety disorders were the most predominant class of disorders across both groups, followed by mood disorders, substance use disorders, and behavioural disorders. The most prevalent individual disorders were phobias and Major Depressive Disorder.

An interesting factor to consider is whether pre-enrollment-onset of mental health issues predicts entry (or non-entry) into postsecondary school. Auerbach et al.'s (2016) research found that a somewhat smaller proportion of respondents who entered postsecondary school (25.3%) than those who did not (28.2% of high school graduates who did not go on to university) met criteria for at least one lifetime pre-enrollment DSM-IV disorder. The authors found that a history of one or more pre-enrollment disorders was associated with significantly reduced odds of attending postsecondary studies, at least in high-income countries.

These results contradict the abundance of research suggesting that postsecondary students have significantly higher rates of mental health issues than the general population. Though informative, these findings do not negate the fact that psychological distress is indeed a problem among this population and is associated with an array of negative consequences, including: lowered academic performance; academic probation; decreased emotional and behavioural skills; social isolation; conflict; postsecondary dropout; decreases in the quality and satisfaction of life; and worse functioning later in life (Harrer et al., 2019; Hunt & Eisenberg, 2010; Storrie et al.,

2010). Psychological distress among university students is also associated with various problematic health behaviours including disturbed sleep patterns, physical aggression, suicidal ideation, self-harm, cigarette smoking, and alcohol and illicit drug use (Fenghshan, 2018; Ontario University and College Health Association, 2017; Sharp & Theiler, 2018).

Factors Associated with Psychological Distress Among University Students

High levels of psychological distress among university students may not seem surprising given that this population goes through a number of complex changes during a particularly vulnerable developmental period, including: transitioning from an adolescent to an adult; moving away from home; transitioning to a less structured and often stressful learning environment; learning to balance academic, social, and financial needs; and encountering cultural challenges (Beiter et al., 2015; Cooke et al., 2006; Ontario University & College Health Association, 2017; Pierceall & Keim, 2007; Vaez & Laflamme, 2008).

When viewed through the lens of Bronfenbrenner's ecological model of human development, mental health outcomes of postsecondary students are seen as the product of multiple factors operating at multiple levels rather than the product of a single risk factor (Byrd & McKinney, 2012). The literature suggests three slightly varying but common sets of factors that tend to be associated with psychological distress among university students. These factors can be summarized as: 1) individual/student related factors; 2) institutional factors; and 3) interpersonal factors (Byrd & McKinney, 2012; Royal College of Psychiatrists, 2003; Sharp & Theiler, 2018).

Individual/Student Related Factors

Individual/student related factors are seen as the strongest contributors to overall mental health (Byrd & McKinney, 2012). These include personal characteristics such as emotional,

cognitive, and physical health, socio-demographics, and intrapersonal functioning (Byrd &

McKinney, 2012; Lipson & Eisenberg, 2018).

Research suggests a link between psychological attributes and psychological distress

among university students. For example, students' lack of confidence and capacity to respond to

stressful situations is strongly related to higher psychological distress (Sharp & Theiler, 2018)

including a greater risk for depression and suicide (Byrd & McKinney, 2012). Unsurprisingly

then, coping skills have been found to have the strongest influence on student mental health

(Byrd & McKinney, 2012). Students' lack of confidence in their communication skills has also

been associated with poorer mental health (Byrd & McKinney, 2012). Moreover, lower

dispositional hope (the belief in one's energy and motivation to achieve a goal and the

confidence in one's ability to meet those goals) has been associated with higher psychological

distress among university students, including depression, generalized anxiety, hostility, and

social anxiety (McDermott et al. 2015; Sharp & Theiler, 2018). Additionally, lower optimism,

higher neuroticism, and low self-esteem tend to predict higher levels of psychological distress

among university students (Sharp & Theiler, 2018). Conversely, higher levels of positive

personality traits, including hope, have been shown to significantly predict less psychological

distress in first year university students (Besser & Zeigler-Hill, 2014). Hopeful students may be

better equipped to cope with negative experiences when they arise (McDermott et al. 2015).

Furthermore, students with a strong self-concept and an internal locus of control tend to be more

confident about their ability to succeed when encountering difficult circumstances (Kuh et al.,

2006).

Unsurprisingly, intellectual functioning plays a fundamental role in a student's academic

success. However, cognitive performance can be hindered by stress and educational challenges

(Nazari & Far, 2019). As expected, academic concerns are a major source of worry for postsecondary students, and those with greater perceived course problems tend to have a greater propensity for emotional problems (Sharp & Theiler, 2018). Similarly, students with greater emotional problems tend to struggle with academic performance and course completion (Sharp & Theiler, 2018) as mental health problems can significantly disrupt learning ability, particularly among students experiencing anxiety and depression (McLafferty et al., 2017). Moreover, students with pre-existing suicidality, suicide attempts, and self-harm have been found to achieve significantly lower grades (McLafferty et al., 2017). Issues with attention and concentration can also have an impact on academic performance and contribute to mental health challenges (McLafferty et al., 2017). The ability to stay focused and manage attention is critical for effectiveness of study time, both in and out of the classroom (Deepa et al., 2022).

When considering the impact of physical health on students' psychological well-being, physical activity has been associated with determinants of mental health, such as better stress management and a lower risk of depression (Bhochhibhoya, et al., 2014). However, physical activity levels among university students tend to decrease due to newly independent lifestyles and demanding work-study schedules (Bhochhibhoya, et al., 2014). A total of 42.9% of American students currently meet the recommended amount of weekly exercise proposed by the American College of Sports Medicine (ACSM) (American College Health Association [ACHA], 2022), while 38.1% of Canadian university students currently meet the recommended amount of weekly exercise (ACHA, Canadian Reference Group, 2022).

University students also tend to practice unhealthy eating habits by consuming less nutritious meals (Ghrouz et al., 2019). The ACHA (2022) survey indicated that 39.8% of American university students reported being overweight or obese, while 35.8% of Canadian

students reported being overweight or obese. Poor physical health and lack of physical activity are associated with psychological complaints such as depression and anxiety (Ghrouz et al., 2019). Moreover, students experiencing psychological distress are more likely to binge drink alcohol and smoke cigarettes with greater frequency (Ghrouz et al., 2019). As well, sleep disturbances, specifically in university students, are linked to depression, obsessive-compulsive behaviour, and general psychological distress (Ghrouz et al., 2019). A bidirectional association has been found between sleep disturbances, anxiety, and depression, suggesting that each contributes to the development of the other (Ghrouz et al., 2019).

Research on socio-demographic characteristics suggests that female students tend to have significantly higher rates of mental health problems (McLafferty et al., 2017). Gender differences have also been found in help-seeking among university students, with female students seeking help at higher rates than their male counterparts (McLafferty et al., 2017). Higher rates of mental health issues have also been found among students who identify as non-heterosexual (McLafferty, 2017). Moreover, university students from disadvantaged families with low socio-economic status have been found to have higher rates of mental health problems (Bayram & Bilgel, 2008; McLafferty et al., 2017). Financial concerns among students have been directly linked to psychological symptoms as some students must go without food, essential travel, or other necessities of living (Sharp & Theiler, 2018). A study conducted with Turkish students also found that those from rural backgrounds were significantly more likely to have elevated depression, anxiety, and stress scores than students who resided in a town or city (Bayram & Bilgel, 2008).

Institutional Factors

Institutional factors also have a significant impact upon students' psychological well-being. These factors refer to the educational setting, including the academic requirements and curricula, teaching practices, and the social and institutional climate (Byrd & McKinney, 2012). Institutional factors have the potential to become chronic stressors that can negatively impact students' psychological and physical health (Byrd & McKinney, 2012).

Students' academic performance and motivation may be directly or indirectly influenced by faculty expectations (Lipson & Eisenberg, 2018). Students who do not feel supported or validated by faculty may have difficulty succeeding in their courses (Lipson & Eisenberg, 2018) which can lead to anxiety and depression (Sharp & Theiler, 2018). This is particularly true for students who feel academically underprepared for university, as well as for those from disadvantaged backgrounds (Lipson & Eisenberg, 2018). Specifically, being criticized by professors has been found to significantly increase stress among students, which can contribute to a fear of failure (Nazari & Far, 2019). Research suggests that students work harder when they feel that university faculty believe in their ability to succeed (Lipson & Eisenberg, 2018). A relatively new perspective on students' reactions to criticism, however, is the idea that the new culture of "safetyism" (protecting people from potentially triggering situations) is encouraging young people to view *perceived impact* as more important than *intention* (Lukianoff & Haidt, 2019). Unfortunately, from this perspective anything can be perceived as harmful, even constructive criticism (Lukianoff & Haidt, 2019). By implementing safetyism— more bluntly viewed as coddling—young adults are deprived of the experiences that challenge them to persevere and grow, thereby making them more anxious and depressed, and prone to seeing themselves as victims (Lukianoff & Haidt, 2019).

The association between students' academic and institutional experience, expectations, and mental health status is highly statistically significant (Lipson & Eisenberg, 2018). For example, Lipson and Eisenberg (2018) found that only 10% of students who were thriving in their studies reported being dissatisfied with their academic experience, while 26% with at least one mental health problem, and 31% with two or more mental health problems reported being dissatisfied with their academic experience. Lipson and Eisenberg also found that nearly half of the students who were thriving strongly agreed that professors believed in their potential to succeed, compared to only 25% of students with at least one mental health problem.

Students' negative perceptions of the campus climate can also impact mental health (Byrd & McKinney, 2012). For example, students who have more negative experiences on campus, such as being singled out because of race/ethnicity, gender, or sexual orientation, are more likely to experience worse mental health (Byrd & McKinney, 2012). Research has shown that the academic environment is particularly stressful for minority students at predominantly white institutions (Byrd & McKinney, 2012).

Institutional structures and processes have also been shown to impact student success and mental health. Among the more important aspects are institutional size, applicant selectivity, campus resources, and faculty-student ratios (Kuh et al., 2006). A student's beliefs about their postsecondary institution are impacted by their experiences with the institution, which then develop into attitudes about the institution, which eventually determine a student's sense of belonging or "fit" with the institution (Kuh et al., 2006). Consequently, students' decisions to persist or leave the institution are likely impacted by their perceptions of the fairness of institutional policies and the responsiveness of faculty and staff (Kuh et al., 2006). Additionally, leadership and decision-making approaches taken by senior administrators may have some effect

on student satisfaction and adjustment (Kuh et al., 2006). In particular, organizational attributes such as level of student involvement in organizational decision making, fairness in the administration of policies and rules, and communication have been found to impact student adjustment and departure decisions (Berger & Braxton, 1998).

Interpersonal Factors

Interpersonal factors are elements that capture how well students function within the social environment. This includes students' level of involvement in social activities, and their level of satisfaction with various social and academic aspects of university life (Byrd & McKinney, 2012). Research indicates that interpersonal and social adjustment are essential for psychosocial development and for dealing with the challenges that accompany university life (Byrd & McKinney, 2012).

Social support has been found to be an important protective factor in helping undergraduate students make the transition to university (Byrd & McKinney, 2012). Developing social support in a university setting involves learning how to negotiate new environments and how to interact effectively with strangers, on and off campus (Kuh et al., 2006). The establishment of new social supports must also be considered within the context of students' pre-existing relationships with family and friends, and the values and norms represented by home life versus those represented by university life (Kuh et al., 2006) which may at times be in conflict. These social networks contribute to student satisfaction, persistence, and the gains experienced in university (Kuh et al., 2006). Peers have been found to be a significant source of influence affecting almost every aspect of development, including cognitive, affective, psychological, and behavioural (Kuh et al., 2006). Differences in social experiences have also been found between students who commute to campus, versus those who live in campus residences (Kuh et al.,

2006). Commuters are less likely to persist in their academic endeavours and have fewer friends on campus (Kuh et al., 2006). Conversely, residential students make more friends, are more tightly connected to the university, and are more likely to persist in the face of adversity (Skahill, 2002).

Satisfaction with academics is closely related to students' social experiences on campus, particularly social connectivity and isolation, as well as overall student engagement (Lipson & Eisenberg, 2018). Research has shown that university connectedness is the most significant predictor of internalizing symptoms, with better connectedness resulting in higher odds of recovery and lower odds of developing significant levels of depression and anxiety (Adams et al., 2021). Socializing and becoming involved with university events, activities, and sports can provide an important outlet to help build resilience (Adams et al., 2021). However, for students suffering from mental illness, perceived stigmatization may lead to discrimination and exclusion (Storrie et al., 2010). Students can feel a sense of social isolation associated with this stigma and may be reluctant to seek help because of it (Storrie et al., 2010).

While some students have the luxury of focusing all of their attention on their studies and social experiences within the university, some students may need to work outside of their studies in order to support themselves and/or their families (Sharp & Theiler, 2018). These students are more likely to experience depression, anxiety, and stress (Sharp & Theiler, 2018). Larcombe and colleagues (2016) found that the number of hours per week spent caring for family members showed consistent associations with all forms of elevated psychological distress.

Mental Health Prevalence Rates Among University Populations

Pre-COVID-19 Prevalence Rates

In 2019, Harrer and colleagues estimated that in any given year, 12% to 46% of all university students around the world would be impacted by mental health issues. It is difficult to ascertain precise prevalence estimates among university populations as assessment methods vary from study to study, most mental health surveys are not globally representative of all students, and response rates tend to be low among this population (Auerbach et al., 2018). In spite of these challenges, the American College Health Association (ACHA) has established a reliable and valid method of collecting comprehensive health information from postsecondary students in the United States and Canada (ACHA, 2021). The ACHA regularly conducts the National College Health Assessment (NCHA) survey, which is a paper or web-based research assessment that collects information from students from multiple self-selected universities (ACHA, 2022). This assessment is particularly useful in providing a comprehensive descriptive profile of the incidence and types of health, behaviour, and psychological distress experienced by postsecondary students (ACHA, 2022). Table 1 shows the ACHA mental health prevalence estimates from American and Canadian universities in the spring of 2019.

Table 1

Spring 2019 12-Month Mental Health Prevalence Estimates from American and Canadian Universities (ACHA, 2019)

Mental Health Issue	American Universities		Canadian Universities
	Undergrad (*N*= 54,497, Full-Time=92.5%)	Undergrad + Graduate[1] (*N*=67, 972, Full-Time=90.9%)	Undergrad + Graduate[2] (*N*=55,284, Full-Time=93.1%)
Overwhelming Anxiety	66.4%	65.7%	68.9%
Depression	46.2%	45%	51.6%
Seriously Considered Suicide	14.4%	13.3%	16.4%
Suicide Attempt	2.3%	2%	2.8%
Intentionally Self-Harmed	9.5%	8.6%	10.5%
Eating Disorder	3.4%	3.2%	3.6%
Very Lonely	67.4%	65.6%	69.6%

[1]Graduate Students made up 17.3% of the American student sample.
[2]Graduate students made up 12.6% of the Canadian student sample.

In spring 2019, ACHA prevalence estimates from American universities suggested that the percentage of students experiencing overwhelming anxiety exceeded the high end of Harrer et al.'s estimate by 20.4%. The percentage of American students experiencing depression aligned with the high end of Harrer et al.'s estimate. It is interesting to note that the inclusion of graduate students slightly reduced prevalence estimates as one may think that the intensity of graduate level studies would increase mental health difficulties. However, it may be that the intensity of graduate studies deters undergraduate students with more significant mental health challenges from pursuing higher levels of education.

ACHA prevalence estimates from Canadian universities in the spring of 2019 included graduate students in the reference group. Canadian findings suggested similar, albeit slightly higher results than the American reference group. As with the American students, the percentage of Canadian students who reported overwhelming anxiety exceeded the high end of Harrer et al.'s estimate by 22.9%. Unlike American students, the percentage of Canadian students who

reported symptoms of depression exceeded the high end of Harrer et al.'s estimate, albeit at a lower percentage than anxiety. The reasons for slightly higher prevalence rates among Canadian university students are not readily apparent in the literature and suggest a potential area in need of future study.

More broadly, in 2018 the WHO World Mental Health International College Student Project (Auerbach et al., 2018) surveyed 13,984 full-time first-year postsecondary students at 19 institutions across eight countries (Australia, Belgium, Germany, Mexico, Northern-Ireland, South-Africa, Spain, United States). Thirty-one percent of students screened positive for at least one 12-month common DSM-IV disorder, and 35% screened positive for at least one common lifetime disorder. Major depressive disorder (MDD) was the most common of the disorders identified by students with an 18% 12-month prevalence. This was followed by generalized anxiety disorder with a 16% 12-month prevalence. The results from the WHO survey support the predominance of anxiety and depressive symptoms among postsecondary students, though the prevalence estimates proposed by this study are lower than those reported by the ACHA.

Current Prevalence Rates

Current prevalence estimates from the ACHA survey are not directly comparable to the spring 2019 estimates due to a revision in the survey methods and the outcomes measured (ACHA, 2022). Nonetheless, the findings still provide valuable insight into current mental health challenges faced by university students. Table 2 shows the findings of the spring 2022 ACHA survey.

Table 2

Spring 2022 12-Month Mental Health Prevalence Estimates from American and Canadian Universities (ACHA, 2022)

Mental Health Issue	American Universities		Canadian Universities
	Undergrad (*N*= 52,204, Full-Time=94.2%)	Undergrad, Graduate[1], PhD[2] (*N*=69,131, Full-Time=91.6%)	Undergrad, Graduate[3], PhD[4] (*N*=11,322, Full-Time=91.6%)
Anxiety	37.3%	35.1%	43.3%
Depression	27.5%	25.7%	30.4%
Suicidal Ideation	29.5%	27.6%	35.5%
Suicide Attempt	2.9%	2.6%	2.9%
Self-Injury	12.1%	10.9%	15.6%
Eating Disorder	4.6%	4.1%	5.7%
Loneliness	53.6%	51.9%	58.6%

[1]Graduate students made up 11.7% of the American student sample.
[2]PhD students made up 8.2% of the American student sample.
[3]Graduate students made up 8.8% of the Canadian student sample.
[4]PhD students made up 4.1% of the Canadian student sample.

While not assessed in the same manner as pre-COVID-19 mental health symptomology, the current mental health prevalence trends among university students provides parallels to the 2019 findings. For example, the current estimates continue to suggest that anxiety and depression are the predominant mental health issues experienced by university students in both the United States and Canada. As well, the inclusion of higher-level students (graduate and PhD) in the American sample once again slightly reduced prevalence estimates. Moreover, as with pre-COVID-19 prevalence rates, Canadian estimates outlined in Table 2 are slightly higher than American prevalence rates, further highlighting the need for research into the reasons for this discrepancy.

Comparing Pre-COVID-19 and Current Prevalence Rates

In order to establish a direct comparison between pre-COVID-19 and more recent mental health prevalence rates, the results of The Healthy Minds Study can be explored. Like the ACHA

survey, The Healthy Minds Study provides a picture of mental health issues in university student populations using validated measures (Healthy Minds Network, 2021). Unlike the ACHA survey, The Healthy Minds Study focuses exclusively on mental health and related issues, which is ultimately better suited to the current study (Healthy Minds Network, 2021). Unfortunately, The Healthy Minds Study does not conduct surveys with Canadian university students, which is why the ACHA survey was used to directly compare American and Canadian university students. Nonetheless, a comparison between pre-COVID-19 and recent prevalence estimates of American university students can provide valuable information about the effects of the COVID-19 pandemic on student mental health. While these estimates cannot be directly compared to Canadian students, particularly since Canadian students appear to demonstrate slightly higher levels of mental health issues, these estimates are nonetheless still useful. Table 3 shows the findings of the fall 2019 and spring/winter 2021 Healthy Minds Study.

Table 3

Fall 2019 and Winter/Spring 2021 12-Month Mental Health Prevalence Estimates from American Universities (Eisenberg et al., 2019; Eisenberg et al., 2021)

Mental Health Issue	Fall 2019 Undergrad, Graduate[1], PhD[2] (*N*=33,372)	Winter/Spring 2021 Undergrad, Graduate[3], PhD[4] (*N*=103,748)
Anxiety	31%	34%
Depression	36%	41%
Suicidal Ideation	14%	13%
Suicide Attempt	1%	1%
Self-Injury	25%	23%
Eating Disorder	11%	12%

[1]Graduate students made up 12% of the Fall 2019 sample.
[2]PhD students made up 5% of the Fall 2019 sample.
[3]Graduate students made up 11% of the Winter/Spring sample.
[4]PhD students made up 3% of the Winter/Spring sample.

The results of The Healthy Minds Study support the literature and the findings of the ACHA survey regarding the predominance of anxiety and depression among university students. Unlike the literature and the ACHA survey, The Healthy Minds Study found that depression had a higher prevalence rate than anxiety at both timepoints. A comparison of the timepoints suggests that there were no real increases in mental health issues among American university students over the course of the COVID-19 pandemic. Unfortunately, there were no current results from The Healthy Minds Study to provide an updated picture of prevalence estimates at the time of the present study.

Anxiety and Depression Among University Students

Anxiety and depression, collectively considered internalizing disorders, are two of the most highly comorbid mental health disorders (Bakker et al., 2016). Eighty five percent of people diagnosed with depression also suffer substantial anxiety, and 90% of people diagnosed with anxiety also suffer substantial depression (Bakker et al., 2016). Anxiety and depression are also the most predominant mental health issues reported by university students (ACHA, 2014; Center for Collegiate Mental Health [CCMH], 2015; Haeger, 2016; Kessler et al., 2005; Sharp & Theiler, 2018).

Anxiety disorders involve intense and prolonged feelings of fear and distress, and often include physiological symptoms (Baxter et al., 2014). They are among the most pervasive mental health conditions worldwide (Bandelow et al., 2017; Michael et al., 2007), and while prevalence rates vary from study-to-study it is estimated that one out of 14 people, or 7.3% of the global population, meet diagnostic criteria for 'any' anxiety disorder at any point in time (Baxter et al., 2014). Anxiety disorders are also associated with a high burden of illness (Bandelow et al., 2017) and disability in terms of health loss, role impairment (Mendlowicz & Stein, 2000), and

disadvantage across the lifespan impacting income, education, and interpersonal relationships (Lochner et al., 2003). Anxiety disorders can develop at any age, however, they tend to start early in life and follow a recurrent, intermittent course (Kessler et al., 2009). In most cases (80 to 90%), anxiety disorders develop before the age of 35, with the time between age 10 and 25 years being a high-risk period (Michael et al., 2007).

Among university students, Generalized Anxiety Disorder (GAD), panic disorder (Auerbach et al., 2018), and phobias (Auerbach et al., 2016) have been identified as the most commonly occurring anxiety disorders. GAD can develop at any age though it has been noted to frequently develop during late adolescence and early adulthood (Michael et al., 2007). It involves somatic symptoms including tremors, palpitations, and nausea, as well as emotional symptoms including nervousness, insomnia, and constant worry (Bandelow et al., 2017). Symptoms of GAD tend to be chronic and wax and wane across the lifespan, fluctuating between clinical and subclinical forms of the disorder (DSM-5, 2013). Panic disorder involves anxiety attacks of sudden onset with physical symptoms of anxiety such as palpitations, sweating, tremors, chest pain, etc. (Bandelow et al., 2017). Individuals with panic disorder are persistently concerned or worried about having more panic attacks and they may change their behaviour in maladaptive ways to avoid future attacks (e.g., avoidance of exercise or of unfamiliar places) (DSM-5, 2013). Specific (isolated) phobias are the most common anxiety disorders among the general population (Bandelow et al., 2017; Michael et al., 2007). They typically start during childhood with a median age of onset of 7 years (Bandelow et al., 2017) and persist over years or even decades (Eaton et al., 2018). They involve extreme fears that are restricted to singular, circumscribed situations, often related to animals or other natural phenomena (e.g., blood, heights, deep water) (Bandelow et al., 2017) and consist of both fear and avoidance (Eaton et al., 2018).

Anxiety disorders tend to run a chronic course, though symptoms can fluctuate in severity (Bandelow et al., 2017). Women are 1.5 to 2 times more likely than men to receive a diagnosis of an anxiety disorder (Bandelow, et al., 2017; Bandelow & Michaelis, 2022). Potential reasons for the higher prevalence rate in women include psychosocial factors, such as childhood sexual abuse and chronic stressors, as well as genetic and neurobiological factors (Bandelow & Michaelis, 2022). Anxiety disorders frequently co-occur with other anxiety disorders, and they are strongly interrelated (Bandelow et al., 2017). Anxiety disorders also tend to co-occur with other mental health disorders, specifically major depression, somatic symptom disorders, personality disorders, and substance use disorders (Bandelow et al., 2017; Michael et al., 2007). Seventy-five percent of people with a lifetime anxiety disorder experience at least one other mental health disorder in their lifetime (Michael et al., 2007).

Depressive disorders involve sad, empty, or irritable moods and are accompanied by physical and cognitive changes that significantly affect a person's ability to function (DSM-5, 2013). Like anxiety, depression is one of the most common mental health issues in the world (Huguet et al., 2016), and while prevalence rates vary, recent estimates suggest that approximately 3.8% of the global population are impacted (World Health Organization, n.d.). People with depression may lose interest in pleasurable activities, they may exhibit changes in sleeping patterns and eating habits, and they may have difficulty concentrating or thinking clearly (Health Quality Ontario, n.d.). These symptoms often have a negative impact on personal relationships, as well as school and work attendance, and performance (Health Quality Ontario, n.d.).

Among university students, Major Depressive Disorder (MDD) is reported to be the most frequently occurring depressive disorder (Auerbach et al., 2016; Auerbach et al., 2018). MDD is

also the most common depressive disorder in the general population around the world (Liu et al., 2020). A total of 93.7% of people who experience substantial depression suffer from MDD (Liu et al., 2020). This disorder can first appear at any age, however, the likelihood of onset increases with puberty, and the incidence appears to peak in the 20s, though first onset in later life is not unusual (DSM-5, 2013). It is most prevalent in females who are 1.5 to three times more likely than males to experience the disorder (DSM-5, 2013), except for the 18- to 24-year-old age group where the prevalence rates between the sexes are similar (Lépine & Briley, 2011). Symptoms of MDD can include depressed mood, diminished interest in pleasurable activities, insomnia or hypersomnia, weight gain or weight loss, psychomotor agitation, fatigue or loss of energy, feelings of worthlessness, difficulty thinking or concentrating, and/or suicidal ideation (DSM-5, 2013). The course of MDD is quite variable, with some individuals rarely experiencing remission, while others experience many years with few or no symptoms between episodes (DSM-5, 2013).

People experiencing depression tend to feel guilty and suffer from significant distress, potentially leading to suicidal thoughts or self-harm (Health Quality Ontario, n.d.). The risk for suicide in depressed individuals is more than 20 times greater than in the general population (Lépine & Briley, 2011). Of further concern, adolescents with severe depression are 30 times more likely to commit suicide than their non-depressed peers (Liu et al., 2020).

It is not only clinically significant levels of anxiety and depression that can be debilitating. Many individuals experience subclinical, or subthreshold symptom levels that can impair functioning and negatively affect quality of life (Firth, Torous, Nicholas, Carney, et al., 2017; Cuijpers et al., 2014; Haller et al., 2014). Subclinical anxiety can include symptoms of frequent nervousness, pervasive worry, pessimistic thoughts, sleep disturbance and fatigue,

suicide attempts, and poorer perceived physical health (Firth, Torous, Nicholas, Carney, et al., 2017; Haller et al., 2014). Individuals with subclinical levels of anxiety have been shown to experience significantly higher levels of distress and lower levels of psychosocial daily activities than those without anxiety (Haller et al., 2014). If left untreated, subclinical levels of anxiety may remit on their own, or they can develop into clinical levels (Firth, Torous, Nicholas, Carney, et al., 2017; Haller et al., 2014).

Subclinical levels of depression can negatively impact day-to-day functioning, and can be associated with decreased quality of life, increased use of health services, economic costs, and mortality rates (Cuijpers et al., 2014). These symptoms can be disabling and put people at risk of developing a depressive disorder; most notably, major depressive disorder (Cuijpers et al., 2014). Research has shown that individuals with minimal and moderate symptoms of depression have an elevated risk of suicidal ideation (Cukrowicz et al., 2011).

Since academic achievement, learning retention, and future success are all related to mental well-being (Glauser, 2017), dysfunctional levels of anxiety and depression can disrupt student success (Fenghshan, 2018). Awadalla and colleagues (2020) found that higher levels of both anxiety and depression were associated with poorer academic performance and lower GPA scores. "Anxiety is a negative, prospective emotion that students experience when they are worried about failure (value) and feel only partially certain about their ability to control the outcome" (England et al., 2019, p. 2). Historically, cognitive components of symptomatic anxiety, such as worry, have been related to poor academic performance (Brackney & Karabenick, 1995). Students with high levels of anxiety also tend to have poorer emotional reactions to academic stressors (Misra & McKean, 2000). Physical symptoms associated with anxiety (e.g., headaches, stomachaches) can also impact academic achievement due to

impairment in a student's ability to attend class, potentially having a negative effect on academic performance and GPA (Alkandari, 2020). Generalized anxiety can result in reduced energy, sleep disturbance, and reduced concentration, all of which can affect academic outcomes (Eisenberg et al., 2009). Moreover, anxiety can persist after graduation and can negatively affect a student's capacity to work in the future (Alkandari, 2020).

Despite being considered a negative emotion, anxiety is also thought of as an activating emotion in terms of its impact on student interest and motivation (England et al., 2019). As a result, the relationship between anxiety and academic performance is more complex than the relationship between depression and academic performance (Awadalla et al., 2020). While some studies suggest a negative relationship between anxiety and academic performance, others have found no relationship between the two (Andrews & Wilding, 2004), while others still have found that students with moderate levels of anxiety have better academic performance (Awadalla et al., 2020). This suggests that at moderate levels, anxiety can actually be productive and may enhance student motivation to perform better (Awadalla et al., 2020; England et al., 2019). However, at very low or very high levels anxiety can impede academic performance (Eisenberg et al., 2009; England et al., 2019). Research has shown that levels of anxiety are higher among female students (Al-Qaisy, 2011) and first-year students (England et al., 2019).

Symptoms of depression have been associated with deficits in short-term memory functioning, particularly on tasks requiring effortful information processing (Brackney & Karabenick, 1995). Depression may affect student productivity, concentration, ability to make decisions, and the amount of time dedicated to academic activities (Eisenberg et al., 2009). Students with depression may miss more classes, assignments, and exams than students who are not depressed (Eisenberg et al., 2009; Hysenbegasi et al., 2005). Depressive symptoms can also

result in hopelessness and/or suicidal thoughts that can decrease interest in investing in the future, thereby impacting academic achievement (Eisenberg et al., 2009). Students with depression have been found to have a lower grade point average than students without depression (Hysenbegasi et al., 2005). They are also more likely to drop courses or drop out of university altogether (Awadalla et al., 2020; Eisenberg et al., 2009). Furthermore, symptoms of depression can impact students' social lives as stigma related to mental illness can negatively affect a person's ability or willingness to engage in university life and social activities (Awadalla et al., 2020).

Depressed people in achievement-oriented environments, such as university, are likely to react to low grades with a sense of failure and low self-esteem due to negative cognitions about themselves, the world, and the future (Beck, 1991). Furthermore, students who hold a negative view of themselves may be reluctant to engage in challenging academic endeavors, which could negatively impact their academic potential (Awadalla et al., 2020; Brackney & Karabenick, 1995). Students with depression can get stuck in a vicious cycle where depression disrupts academic productivity and poor academic performance contributes to low mood (Awadalla et al., 2020). Interestingly, Hysenbegasi and colleagues (2005) found that depressed students who received treatment for their symptoms increased their GPA scores to levels statistically similar to non-depressed students, thereby supporting a causal relationship between depression and academic performance. This causal relationship has been endorsed by numerous studies (Al-Qaisy, 2011; Awadalla, 2020; Eisenberg et al., 2009) firmly supporting the finding that higher levels of depression are associated with lower academic achievement and lower GPA.

Depression appears to interact with anxiety, with the association between depression and academic outcomes being particularly strong among students who also have anxiety (Eisenberg

et al., 2009). Co-occurring depression and anxiety are also associated with substantially higher severity of illness, functional impairment, and chronicity (Eisenberg et al., 2009). Anxiety and depression are not directly caused by stressors; instead, they are states that result from a person's perception and reaction to stressors (Beck & Clark, 1997; Mahmoud et al., 2012). The impact of stressful experiences is mediated by a person's ability to effectively cope with these experiences (Mahmoud et al., 2012). Unfortunately, adolescents and young adults tend to use more maladaptive coping strategies, such as escape-avoidance, than other age groups (Mahmoud et al., 2012). Maladaptive coping strategies can include denial, alcohol and substance use, behavioural disengagement, self-blame, and giving up (Mahmoud et al., 2012). These strategies are used with the intention of reducing anxious or depressive feelings (Olthuis et al., 2015), however, students who frequently use these types of coping strategies tend to report significantly higher levels of anxiety and depression (Mahmoud et al., 2012). Of further concern, the likelihood of self-injury is considerably higher for students with depressive and anxiety disorders (Gollust et al., 2008). This is particularly concerning given that suicide is now the second most prevalent cause of death among young people aged 15 to 29 around the world (Garrido et al., 2019).

Treatment for Anxiety and Depression

Symptoms of anxiety occur on a continuum and many people with milder symptoms—particularly of recent onset related to stressful life events without impairment in social and occupational functioning—will experience an improvement in their symptoms without specific intervention (Baldwin et al., 2005; Bandelow et al., 2017). However, treatment is indicated when anxiety results in significant distress and impairment (Baldwin et al., 2005; Bandelow et al., 2017). The need for treatment is determined by a number of factors, including the severity and persistence of anxiety symptoms, the level of disability and impact on social functioning, and the

presence of comorbid mental disorder or physical illness (Baldwin et al., 2005). The presence of significant coexisting depressive symptoms is an important consideration in the treatment of anxiety (Baldwin et al., 2005). When depression follows, or is comorbid with an anxiety disorder, it is suggestive of greater severity of anxiety and poorer prognosis (Baldwin et al., 2005). Unlike treatment considerations for anxiety, treatment for depression is recommended even in mild cases as early intervention can help prevent more serious depression from developing (American Psychiatric Association, 2010). However, as with treatment considerations for anxiety, symptom severity and comorbidity are important considerations in treatment approaches for depression (American Psychiatric Association, 2010). The main treatment options for anxiety and depression are similar and include a range of pharmacological interventions and psychological therapies based on cognitive behavioural methods (Baldwin et al., 2005). Psychological interventions for reducing symptoms of anxiety and depression can be used in addition to, or in place of pharmacological treatment (Sucala et al., 2017). For the purposes of the current study, psychological interventions will be the focus.

The most empirically supported psychotherapies for anxiety and depression involve cognitive and behavioural approaches (Deacon & Abramowitz, 2004; Flynn & Warren, 2014; Hofmann et al., 2012). The efficacy of cognitive behavioural therapy (CBT) for anxiety and unipolar depressive disorders has been demonstrated in many controlled studies making it a reliable first-line treatment approach (Bandelow et al., 2017; Hofmann et al., 2012; Meng et al., 2021). CBT explores the links between thoughts, emotions, and behaviour with the goal of alleviating distress by helping people to develop more adaptive cognitions and behaviours (Fenn & Byrne, 2013). An emerging cognitive behavioural approach is transdiagnostic CBT, which targets debilitating symptoms that cut across different diagnoses (Flynn & Warren, 2014). This

approach considers the fact that mood and anxiety disorders have more commonalities than differences, and that the two disorders tend to overlap (Flynn & Warren, 2014).

Specific to symptoms of depression, research suggests that behavioural activation (BA) therapy, a more radical behaviorist approach to treating depression, is just as successful as CBT. (Roiser et al, 2012). This psychotherapeutic approach ignores internal cognitions and operates on the premise that avoidance (driven by negative reinforcement) is the central cause of depression and seeks to re-engage people in positively reinforcing activities (Roiser et al., 2012). Interpersonal psychotherapy (IPT) also has demonstrated efficacy in treating symptoms of depression (Cuijpers et al., 2016; Markowitz et al., 2014). IPT focuses on feelings within interpersonal situations helping people to understand that these feelings are useful signals in interpersonal encounters (Markowitz et al., 2014). IPT also shows some promise for treating anxiety disorders, specifically social anxiety disorder, panic disorder, and PTSD, although this treatment modality has not been shown to be more advantageous than other psychological treatments for anxiety (Markowitz et al., 2014).

When avoidance of feared situations is a component of anxiety, exposure techniques should be included in the treatment approach (Bandelow et al., 2017). In exposure therapy, clients "make contact with the feared stimuli (either imaginary or in vivo) and this contact is maintained until the anxiety associated with the contact subsides" (Ougrin, 2011, p. 1). Exposure therapy is useful in treating most anxiety disorders, and it has been proven to be particularly helpful in treating phobias, panic disorder, social anxiety disorder, obsessive-compulsive disorder, posttraumatic stress disorder, and generalized anxiety disorder (American Psychological Association, n.d.).

The literature suggests that the field of CBT is shifting towards a metacognitive model of change and treatment for anxiety and depressive disorders (Flynn and Warren, 2014). A metacognitive approach goes beyond changing one's thinking and highlights the importance of 'thoughts' about thoughts themselves, and experiences (Flynn & Warren, 2014). These approaches include mindfulness-based cognitive therapy (MBCT) and acceptance and commitment therapy (ACT) (Flynn & Warren, 2014). In MBCT people "are aware of negative automatic thoughts and find ways to change their relationship with these thoughts, learning that thoughts are not facts." (Flynn & Warren, 2014, p. 50). Research suggests that MBCT is effective in treating both anxiety and depression (Webb et al., 2016). ACT focuses on changing the function of thoughts and strives to help people accept their internal experiences, such as unwanted thoughts, feelings, bodily sensations, or memories (Flynn & Warren, 2014). As with MBCT, research supports the efficacy of ACT in treating both anxiety and depression (Webb et al., 2016). Similar to ACT, dialectical behaviour therapy (DBT) teaches people to accept their thoughts, feelings and behaviours, along with teaching interpersonal skills. DBT also has proven efficacy in treating symptoms of anxiety and depression, particularly treatment resistant forms of these disorders (Falabella, et al., 2022).

If left untreated, symptoms of anxiety and depression can lead to more complicated mental health issues (Crady, 2005; Forman & Gatteau, 2019). Young adults are at a particularly influential age, and it is during these years that a person can effectively introduce and develop new habits that will help maintain and manage mental health. For those young adults heading to university, these institutions are an ideal place to provide useful resources and interventions to multiple students in a single, shared environment to help them develop healthy behaviours (Hunt & Eisenberg, 2010; Lee & Jung, 2018). University mental health services can have a high profile

on campuses as universities typically represent the only time in many people's lives when a single integrated setting encompasses activities, including health and other supports (Hunt & Eisenberg, 2010). This makes these institutions an ideal setting to increase awareness of the signs and symptoms of psychological distress and associated support, whether on or off campus.

Barriers to Treatment Among University Students

The university years represent a developmentally challenging transition to adulthood; a critical developmental period in which young adults must learn to cope with stress and develop healthy habits that will contribute to success and well-being later in life (Hunt & Eisenberg, 2010). Acquisition of coping skills and healthy habits are not typically part of university curricula, and students are therefore left to their own devices to develop these life skills while balancing academic demands and other life commitments; thus, contributing to an already challenging developmental period that is known to have a high prevalence of mental health issues. Despite this challenging period and high prevalence of psychological distress, nearly two-thirds of students with self-identified mental health issues do not use any form of mental health services, even when on-campus services are available (Dunbar et al., 2018; Eisenberg et al., 2011). This is highly unfortunate, as early intervention could prevent adverse outcomes often associated with mental health issues, such as substance misuse, educational underachievement, and suicide (McCloud et al., 2020). Help-seeking intentions are multifaceted, and barriers to accessing mental health support affect students disproportionally (Broglia et al., 2021). These barriers include both student and institutional factors.

Student Barriers

Student barriers are those that are internal (psychological) and can include lack of awareness about mental illness or about mental health services (Dunley & Papadopoulos, 2019).

For some students, the symptoms of mental illness can be difficult to identify as these issues may be considered a "normal" and "expected" part of the postsecondary experience (Dunley & Papadopoulos, 2019; Kirsh et al., 2016; Markoulakis & Kirsh 2013). A survey of 165 college students found to be at elevated risk for suicide found that 66% did not feel that they needed mental health services (Hom et al., 2015). Robinson and colleagues (2016) found that within a group of students who were found to objectively meet criteria for psychological distress on standardized measures, 32.5% had not accessed services because they did not *subjectively* feel like they were in distress. The authors reported that distressed students were more likely to feel uncomfortable accessing services than non-distressed students (28.7% compared to 12.7%, respectively). Some students report having limited knowledge of campus counselling services while others identified difficulty navigating these services (Dunley & Papadopoulos, 2019). However, lack of service awareness is unlikely to play a large role in underutilization of services, as Robinson and colleagues (2016) found that a large majority of students (74%) were aware of the services available to them on campus. This may suggest that some students have difficulty navigating the services available to them. The underutilization of student counselling services is unfortunate given that student retention has been shown to be strengthened when students experiencing psychological distress access these services (Lee et al., 2009; Robinson et al., 2016). Research conducted by Lee and colleagues (2009) found that students who accessed student counselling services when needed were three times more likely to complete their program of study than those who did not access counselling when needed.

Another factor that reflects more of a preference than a barrier involves students who prefer to manage mental health problems on their own (Davies et al., 2014; Dunley & Papadopoulos, 2019; Hom et al., 2015; Kirsh et al., 2016). Broglia and colleagues (2019), found

that 75% of the students they surveyed would not seek professional help for an emotional or mental health problem because they would rather tackle the issue alone or seek help from friends. Similar findings were also reported by Eisenberg and colleagues (2007), who found that students struggling with depression were more likely to turn to friends, family, or other support rather than mental health professionals. Indeed, some students express doubts about the efficacy of professional help (Hom et al. 2015; Robinson et al. 2016).

Some studies have also identified stigma and personal beliefs as major barriers to help-seeking among people experiencing mental health difficulties (Dunley & Papadopoulos, 2019). However, a 2015 review by Hom and colleagues called into question whether stigma associated with mental health is the significant barrier it is often thought to be, as only 12 to 13% of participants in the literature identified stigma as a barrier to care. Moreover, Eisenberg and colleagues (2012) found that 65% of American college students reported low stigma and positive beliefs about treatment effectiveness. These results could suggest that stigma regarding mental health has become less of a barrier to help-seeking (Dunley & Papadopoulos, 2019; Eisenberg et al. 2012), or it could be that students are not reporting their experience of stigma. Either way, stigma remains a complex phenomenon that interacts with other factors and barriers and is likely to continue to impact some students. In relation to stigma, privacy concerns on campus have also been identified as a student barrier to help seeking as some students fear that others may become aware of their personal difficulties if they seek support (McCloud et al., 2020).

Lack of time has also been identified by students as a significant barrier to help-seeking (Dunley & Papadopoulos, 2019). Robinson and colleagues (2016) found that 43.5% of the students in their sample identified lack of time as the main barrier to help seeking. Even though counselling appointments are typically only an hour in length, students must fit these

appointments into their busy class schedules. They may also need to plan how to get to and from

these appointments if the service is off campus, or if a student lives off campus but is accessing

on-campus support. The findings of Robinson and colleagues suggest that even for students in

distress, help-seeking behaviour is not urgent enough to compete with other demands on their

time. Another problematic issue is that students are often placed on wait lists, and by the time the

appointment arrives students may no longer have the same levels of distress and may feel as

though they no longer need help (Dunley & Papadopoulos, 2019). To address the problem of

wait times, some universities have established drop-in hours to offer students more immediate

help (Dunley & Papadopoulos, 2019).

An additional student barrier to help seeking is the frequent failure of postsecondary

students to adhere to interventions, citing lack of energy, along with previously mentioned lack

of time (Glissman, 2018). Even when the duration of interventions and length of sessions is

reduced, low attendance is still reported with percentages ranging from only 33% to 43% of

students attending recommended sessions (Glissmann, 2018).

Institutional Barriers

Institutional barriers refer to obstacles at the university or community level that impact

students' ability to access mental health services (Dunley & Papadopoulos, 2019). Students

frequently identify institutional and structural factors as obstacles to seeking help for mental

health issues, even though most large and medium-sized universities provide mental health

services to students (Dunley & Papadopoulos, 2019; Heck et al., 2014). Some of these barriers

may only be 'perceived' and may be attributed to students' lack of understanding of campus

counselling services, or previous negative experiences with these services (Bray & Born, 2004;

Dunley & Papadopoulos, 2019). Where institutional barriers do exist, it is likely due to a lack of

organization, communication, and coordination among service providers, both within and outside of the university setting, including university counselling services, disability services, and community-based services (Dunley & Papadopoulos, 2019).

Another potential institutional barrier for help-seeking may be related to cost and health insurance coverage (Dunley & Papadopoulos, 2019). This is despite the fact that most universities (69% of Canadian universities) offer on-campus mental health services at no (direct) cost, or at a reduced cost to students (Dunley & Papadopoulos, 2019; Robinson et al., 2016). Nonetheless, there are usually long wait times at university counselling centers, resulting in the need to refer students to outside services (Dunley & Papadopoulos, 2019) which could incur a cost to students. According to research done by Dunley and Papadopoulos (2019), many university plans are capped at approximately $300 per year for outside services, with the typical cost of just one counselling appointment exceeding $100. Plans with limited coverage were found to only cover $12 to $20 per visit (Dunley & Papadopoulos, 2019).

Current Situation

According to the World Health Organization, postsecondary schools around the world are facing an increasingly challenging dilemma; the need to provide exceptional educational opportunities while contending with high rates of mental health challenges among students (Auerbach et al., 2019). Despite student and institutional barriers to help seeking among post-secondary populations, current research suggests that there is an increase in the demand for counselling services on university and college campuses (Glissmann, 2018; Lee & Jung, 2018) with many students struggling to cope with long wait times and limited resources (Lattie et al., 2019). For example, the average wait time to receive mental health treatment services at

Canadian postsecondary counselling centers is 19.3 weeks, and students at some institutions may have to wait up to six months for individual treatment (Lee, & Jung, 2018).

In 2015, the Center for Collegiate Mental Health reported that student usage of university counselling services grew by 30% over a five-year period, while the average institutional enrollment grew by only 5%. Counselling center directors have expressed concern with the growing demand for services without an appropriate increase in resources (Loiacono et al., 2018). With large student populations and limited funding, universities and colleges are looking for innovative ways to respond to mental health issues among their students (Glissmann, 2018).

While many universities provide much needed services and programs to support student mental health, there are still problems with these services (Lee & Jung, 2018). Despite an increase in demand for on-campus counselling, university counselling centers are typically understaffed and unable to meet these demands (Lee & Jung, 2018). Furthermore, on-campus counsellors are often instructed to provide short-term interventions for students, while policies often limit the number of sessions allowed (Lee & Jung, 2018). These policies are designed to allow a greater number of students access to services, but they do not guarantee that students will receive the long-term support they may require (Lee & Jung, 2018). Some postsecondary institutions have implemented group counseling sessions to address this concern; however, given some students' concerns with stigmatization, this type of intervention may not be appealing (Lee, & Jung, 2018).

Many universities offer stress management programs, including education, resources (e.g., pamphlets, presentations, workshops), and opportunities for students to participate in mind, body, spirit, and general wellness activities (e.g., yoga, meditation, biofeedback, massage) (Glissman, 2018). Mindfulness interventions have become popular on university and college

campuses and may be an effective strategy to reduce student stress (Glissmann, 2018). Despite a variety of projects to promote mental health on university and college campuses, resources are still inadequate, whether financial (lack of funds) or human (lack of counsellors or psychologists) (Giamos et al., 2017). Giamos and colleagues (2017) also found that available services are not promoted efficiently and openly, and accessibility needs to be improved. The Canadian Association of College and University Student Services (CACUSS) (2013) and the Canadian Mental Health Association (2013) have stressed the importance of improving the accessibility of mental health services to promote greater student retention.

The high prevalence of mental health issues among university students has led some postsecondary institutions to take drastic measures. Universities across Canada and the United States have introduced controversial involuntary leave policies that empower school officials to remove students struggling with serious psychological challenges (Buckley et al., 2020). According to university officials, these policies are designed to encourage students who pose a risk to themselves or others to get help before safely returning to school (Buckley et al., 2020). The problem inherent in this approach is that it does not require the university to assist students; rather, it allows universities to put students on leave and withdraw essential services (housing, health, and counselling services) at a time when students are in crisis and most in need of support (Buckley et al., 2020).

In Canada, changes have been made at the national and provincial levels to address student mental health needs. For example, CACUSS (2013) established a framework to educate postsecondary students about coping and crisis management skills through accessible community mental health and counselling services. Some provinces, such as Ontario, have pledged to invest millions of dollars to support the province's Mental Health Innovation Fund and other initiatives

that advocate for student-led projects to raise awareness about mental health supports (Giamos, et al., 2017; Perez et al., 2014). The Mental Health Commission of Canada also established an agenda to transform and build capacity among campus mental health services (Giamos et al., 2017). While progress has been made, mental health issues on campuses remain inadequately addressed. There is a need for postsecondary institutions to strive for more systematic approaches to mental health resources to deliver services more effectively and efficiently to students in need of support (Giamos et al., 2017; Heck et al., 2014).

Worldwide, approximately 15.85 million young adults are enrolled in undergraduate studies (Education Data Initiative, n.d.). In Canada, over two million students are enrolled in postsecondary studies (Statistics Canada, n.d.). With so many young adults at risk, academic institutions are the ideal place to promote interventions for mental health (Kajitani et al., 2020). As such, mental health challenges among university students represent not only a growing concern, but also an opportunity to reach a large number of individuals who could benefit from interventions during an important period of life (Hunt & Eisenberg, 2010).

Internet-Delivered Mental Health Interventions

Given the prevalence of mental health issues among postsecondary students, innovative approaches are needed to ensure that students have easy access to accurate mental health information and interventions (McCloud et al., 2020). One of the most promising mediums to aid in the delivery of mental health interventions is the internet (Heber et al., 2017). With pervasive internet access and the spread of computerized technologies, new methods for providing mental health interventions have emerged (Firth, Torous, Nicholas, Carney, et al., 2017). There has been a proliferation of web-based interventions for the prevention and treatment of a range of psychological issues in recent years (Heber et al., 2017). These interventions have many

advantages that may overcome some of the limitations of face-to-face approaches, such as anonymity and immediate 24/7 availability (Heber et al., 2017).

Evidence suggests that computerized versions of cognitive and/or behavioural therapies can provide effective, remote treatment for anxiety disorders, and reduce symptoms with similar efficacy to in-person treatment (Andrews et al., 2010; Firth et al., 2017). The Ontario Health Technology Advisory Committee (Health Quality Ontario, 2019 p.1) found that "guided internet-delivered cognitive behavioural therapy (iCBT) for mild to moderate major depression and anxiety disorders improves symptoms and provides good value for money". Unfortunately, iCBT is not publicly funded in Ontario (Health Quality Ontario, 2019), and therefore is likely not a feasible option for many university students. As such, the need for free access to effective web-based mental health interventions may be an important alternative and/or addition to traditional mental health interventions offered to university students.

Exploring internet-delivered options to address students' mental health challenges could increase student satisfaction, improve student retention rates, and prevent emotional crisis situations on campuses (Forman & Gatteau, 2019). It is thought likely that internet-delivered interventions could easily be offered to student populations in a practical and cost-effective way (Bubolz et al., 2020; Levin et al., 2017). This alternative intervention could help reduce high service demands placed on university counselling centers and enable more students to receive services. Internet-delivered interventions could also help reach students earlier in their mental health struggle than traditional in-person counselling (Heber et al., 2017) and may increase help-seeking behaviour among those who need it most (Levin et al., 2018).

A breadth of literature has emerged over the past few decades demonstrating the efficacy of internet delivered psychological self-help interventions for a variety of problems relevant to

students, including depression, anxiety, eating disorders, and addictions (Levin et al., 2018). The self-guided online format of internet-delivered interventions has the potential for broad distribution of information to large student populations. In fact, most university and college counseling centers have been utilizing the internet for some time to provide psychoeducational information on their websites to address the demand for mental health services on campuses (Levin et al., 2018; Loiacono et al. 2018). Online self-help may be a promising alternative to address the increasing demands for mental health services and could potentially reduce the public health burden of psychological disorders (Levin et al., 2018).

In support of internet delivered interventions, Harrer and colleagues (2018) found moderate to large effects for the reduction of stress, and substantial effects for the reduction of depression among postsecondary students who used an internet-based, app-supported stress management intervention. Furthermore, a systematic review and meta-analysis of internet-based interventions used by university students found small effects on depression, anxiety, and stress, and moderate-sized effects on eating disorder symptoms and social and academic functioning (Harrer et al, 2018). Bendtsen and colleagues (2020) found that a fully automated mHealth intervention was effective in increasing positive mental health among university students and had a protective factor on depressive and anxiety symptoms. Their findings also suggested that the mHealth intervention may have been superior to usual care in increasing positive mental health among students.

Mobile Mental Health Interventions

A mobile application, also known as a 'mobile app', or simply an 'app', is a self-contained program or piece of software that is designed to fulfill a specific purpose and is optimized to run on mobile devices such as smartphones, tablets, and wearable devices such as

smart watches (Lui et al., 2017; Palos-Sanchez et al., 2021). Mobile applications are used for a

myriad of purposes, such as playing games, getting directions, or accessing weather updates.

Since the creation of Apple's iTunes App Store and Google's Android Market, Google Play, in

2008, which allowed users to download mobile application software, a multitude of sophisticated

mobile apps have been developed (Giota & Kleftaras, 2014).

In recent years, the health care field has taken an interest in mobile apps due to the wide-

scale application and prevalence of smartphone technologies (Armontrout et al., 2018). The use

of mobile technology in health care has been labelled mHealth (Luxton et al., 2011; Mohr et al.,

2017). As of 2017, there were approximately 325,000 mobile health apps available, with mental

health apps making up about one third of disease-specific apps (Neary & Schueller, 2018). As of

2021, there were approximately 20,000 mental health apps, and current global spending on these

types of apps is estimated to be approximately $500 million per year (Auxier et al., 2021). The

literature suggests that consumers are very interested in mHealth apps, with community samples

and psychiatric patients expressing positive attitudes toward using apps to self-manage their

mental health (Neary & Schueller, 2018). Consumers find mHealth apps easy to use (Palos-

Sanchez, 2021) and tend to feel more empowered and in control of their difficulties as a result of

the information learned from the apps (Vo et al., 2019).

mHealth apps have the potential to facilitate and enhance mental health care as they can

support individuals in managing their mental health either as a stand-alone treatment, or as an

adjunctive to traditional treatment practices. More specifically, mHealth apps can be used to

access information about mental health care, offer guided or self-help techniques and exercises,

and allow for real-time exchanges with mental health care specialists if necessary (Neary &

Schueller, 2018). When used in a clinical context, mHealth apps can help with symptom

assessment, provide psychoeducation, track treatment progress, provide real-time intervention

and communication, and take advantage of game technologies and global positioning systems

(GPS) (Lui et al., 2017; Luxton et al., 2011). Moreover, apps can be personalized and are

visually appealing, user-friendly, self-paced, and have multimedia capabilities (Lui et al., 2017).

These features can help improve user engagement, motivation, and adherence, which could lead

to better clinical outcomes (Lui et al., 2017). This could be particularly appealing for university

students who are very familiar with and rely heavily on technology. For this population,

conventional forms of counselling and appointment management may no longer be as interesting

as immediately available tools and resources. As such, mHealth apps may provide a timely

alternative for managing mental health issues among university students (Lattie et al., 2019). For

those students who still prefer in-person interventions, they are likely to seize on the availability,

convenience, and confidentiality of internet-based resources while on waitlists for in-person

services (Holtz et al., 2020).

In support of mHealth apps, a meta-analysis found that smartphone interventions had a

moderate positive effect on symptoms of depression and anxiety when compared to active

control conditions (Firth, Torous, Nicholas, Carney, Pretap, et al., 2017). The effects were found

to be substantially larger when compared to inactive control conditions. Research conducted by

Lee and Jung (2018) found that using a smartphone app (DeStressify) for 4 weeks resulted in

reduced trait anxiety and improved emotional well-being among university students. McCloud

and colleagues (2020) found that using a smartphone app (Feel Stress Free) for a period of 6

weeks reduced symptoms of depression and anxiety in university students. Furthermore, research

conducted by Ponzo and colleagues (2020) found that a 4-week intervention with a mobile app

(BioBase) significantly reduced anxiety and increased well-being among university students.

Most apps range in cost from free to a few dollars and can be downloaded by anyone with a mobile device (Neary & Schueller, 2018). mHealth has the potential to remove barriers associated with cost, transportation, lack of therapists, lack of insurance, and lengthy wait times (Lui et al., 2017). mHealth could also help address geographical barriers for hard-to-reach populations, or those who typically would not seek help through traditional routes (Bry et al., 2018; Marshall et al., 2019a). mHealth could also reduce stigma and increase privacy as there is no need to attend a treatment facility or speak directly to a therapist (Van Ameringen, 2017; Wang et al., 2019b). Additionally, the convenience and portability of mobile technology allows interventions to be delivered in the moment of need at any time and in any location (Lui et al., 2017). This is particularly beneficial during situations of high-risk or significant distress (Lui et al., 2017; Luxton et al., 2011). mHealth apps could also offer brief services to those who may have less severe symptoms, opening services for clients requiring more intensive in-person interventions (Lui et al., 2017).

Problems with Mobile Mental Health Interventions

As one of the largest growing areas in e-mental health, mobile mental health applications are being downloaded at increasing rates (Marshall et al., 2019b). As a result, mHealth app development has significantly outpaced app research (Van Ameringen et al., 2017; Wang et al., 2018). As such, there are concerns about the effectiveness of mHealth apps, and the research methodologies used to examine them (Marshall et al., 2019a). There are currently no standardized assessment methods for assessing the efficacy of mental health apps (Marshall et al., 2019a) and most commercial apps limit evaluation to user engagement metrics such as the number of downloads, time spent using the app, money spent on the app, or user ratings in the app stores, rather than clinical outcomes (Gratzer et al., 2019; Marshall et al., 2019a).This is

concerning as many apps are categorized under "mental health" even though the interventions offered do not qualify as comprehensive therapeutic treatments (Marshall et al., 2019a). Even apps created by reputable organizations and those incorporating components of evidence-based treatments have not fully validated their effectiveness (Van Ameringen et al., 2017). This lack of evidence is likely attributable to the fact that mHealth app developers lack the necessary expertise to produce validated apps, and only 5% include a medical expert on their team (Van Ameringen et al., 2017). Therefore, despite the tremendous potential of mHealth apps to extend the reach of mental health care, the existing literature does not adequately support the supposed benefits (Van Ameringen et al., 2017). Further complicating the matter, the ever-expanding availability of apps continually leads to changes in the app market, resulting in the removal of apps approximately every 2.9 days (Van Ameringen et al., 2017).

Lack of evidence makes it difficult for consumers and professionals alike to know which mHealth apps have relevant information and appropriately endorsed therapeutic interventions (Van Ameringen et al., 2017). In 2017, Sucala and colleagues searched the iTunes App Store and Google Play (which are considered the most widely used platforms for smartphone apps) for apps to help people cope with anxiety disorders. Of the 52 apps analyzed, the majority (63.5%) offered no information about the intervention. More than two-thirds (67.3%) did not offer information about the professional credentials of the app developers or consultants, and 96.2% did not offer any information about the efficacy data supporting the apps use for the marketed purpose.

An additional problem with mHealth apps is that while many are based on the gold standard of evidence-based interventions, transferring an intervention from one modality to another typically requires validation to be deemed effective (Van Ameringen et al., 2017).

Cognitive behaviour therapy (CBT) is considered an empirically supported first-line treatment approach for anxiety and depression (Bandelow et al., 2017; Hofmann et al., 2012; Meng et al., 2021), however, modifying this treatment approach for internet-based CBT programs is challenging as these efforts often utilize large bodies of text that are not ideal for mobile devices (Van Ameringen et al., 2017). To accommodate, app developers typically shorten the text for mobile platforms, potentially altering the psychometric properties of the intervention and reducing the previously established validity (Van Ameringen et al., 2017). Similar limitations exist with assessment and tracking apps that use validated clinical measures that have not been evaluated on smartphone devices (Van Ameringen et al., 2017). As with mental health interventions, assessment tools must also be revalidated when transformed into a different format (Van Ameringen et al., 2017).

An additional concern with mHealth apps involves digital privacy and confidentiality. App developers cannot confirm that users have read and fully understood the risks and benefits associated with using the app, nor can they verify that the user is competent to provide informed consent (Prentice & Dobson, 2014). Further, unauthorized individuals can potentially access data gathered from apps through digital theft or physical loss of the mobile device (Luxton et al., 2011; Prentice & Dobson, 2014). Apps may also have inadequate data protection, such as lack of encryption, and/or may not fully disclose to users which information is automatically gathered and returned to software developers (Luxton et al., 2011; Prentice & Dobson, 2014). Moreover, some apps have embedded advertisements that could result in personal information being provided to marketers and advertisers, particularly in the case of free apps (Giota & Kleftaras, 2014). Similarly, apps that have the functionality to connect to social media pose further risk as

personal information may be shared with social networking sites without the knowledge of the user (Lui et al., 2017).

Of further concern, the user retention rate for smartphone apps in the general population is low, with approximately 25% of users abandoning apps after one use (Bauer et al., 2020). In 2016, the worldwide app retention rate for both Android and Apple smartphones after 90 days was just 4% (Bauer et al., 2020). Usage reports for health apps, including those for mental health, show limited downloads and poor retention, especially outside of clinical trials and research settings (Bauer et al., 2020). Additionally, most consumers seek out mHealth apps through social media, web searches, or word of mouth rather than professional recommendations (Bauer et al., 2020; Schueller et al., 2018). Many also rely on online app reviews, which can be misleading (Bauer et al., 2020). For instance, 25 of the most popular iPhone apps for anxiety and worry, as indexed by user ratings, did not include content consistent with evidence-based treatments (Bauer et al., 2020). Cost has also been identified as an important factor in user ratings as free or lower priced mHealth apps have consistently higher consumer ratings than higher priced apps, despite app content (Marshall et al., 2019b). While consumers can find information related to independent app reviews online through the Organization for the Review of Care and Health Apps (ORCHA) (Humber and North Yorkshire Health and Care Partnership, n.d.), there have been no clear guidelines, regulations, or recommendations for consumers to select mHealth apps (Larsen et al., 2019; Marshall et al., 2019a). As such, consumers may find it difficult and overwhelming to select the most appropriate app from hundreds of options available on the app market (Larsen et al., 2019).

Ineffective mHealth apps may discourage individuals from seeking further treatment, or they may have harmful effects on those in need of intervention (Price et al., 2014). For example,

an individual with substantial mental health issues may feel that using an ineffective app is sufficient and they may not seek much needed additional care as a result (Price et al., 2014). These concerns highlight the need for research on the acceptability and effectiveness of mHealth apps (Price et al., 2014).

Lastly, many people have a high level of affinity for their digital devices and have certain expectations of their device's capabilities (Torous & Firth, 2016). This could lead to a digital placebo effect, which is placebo-like effects seen from mobile health interventions, such as smartphone apps (Torous & Firth, 2016). In one of the first studies of mental health apps, Kauer and colleagues (2012) provided a good example of the digital placebo effect. The study involved a smartphone app designed to help patients self-monitor and record their symptoms of depression. Even without any direct therapeutic intervention, smartphone self-monitoring significantly reduced symptoms. There is also indication from marketplace data that digital placebo effects could be driving user satisfaction (Torous & Firth, 2016). That is, beliefs about technology, perceptions of being more connected to health-care providers through remote monitoring, the design of the app, and the information provided by the app may all contribute to user satisfaction regardless of actual app efficacy (Torous & Firth, 2016). For example, a review of over 700 mindfulness apps revealed that only 23 actually provided mindfulness training or education, and only one was reported to be supported by empirical evidence (Mani et al., 2015; Torous & Firth, 2016). Although these data do not provide proof of the existence of a digital placebo effect, the findings do suggest that placebo could be partly responsible for the high number of downloads of apps with little scientific evidence of effectiveness (Torous & Firth, 2016).

While the literature suggests some promising results for mobile mental health applications (mHealth apps) in treating anxiety and depression, more research is needed to corroborate the results (Harrer et al., 2018; Wang et al., 2018). If proven to be effective, mHealth apps could be a viable mental health intervention, either as a stand-alone self-help treatment, or an adjunctive to traditional therapy. This is especially promising and appealing for university students who are under a great deal of stress and have busy schedules and limited resources to seek professional help.

Rationale for the Current Study and Hypotheses

The present study sought to evaluate the utility of three self-guided mHealth apps in reducing levels of psychological anxious distress in university students. Moreover, since anxiety and depression often co-occur (DSM-5, 2013) and research suggests that depression is second to anxiety as the most predominantly distressing issues affecting university students, the efficacy of reducing levels of psychological depressive distress was also measured.

The first hypothesis was that students who used an mHealth app for six weeks would show a decrease in levels of psychological anxious distress compared to those students who used an active smartphone-based control in the form of a leisure-based colouring app. The second hypothesis was that students who used an mHealth app for six weeks would show a decrease in levels of psychological depressive distress compared to those students who used an active smartphone-based control.

It was also predicted that there would be no difference in effectiveness among the mHealth apps. The use of an active smartphone-based control was an important consideration to help determine if significant results were attributable to the science behind treatment-based apps,

or to a digital placebo effect based on the use of an app itself, regardless of therapeutic effectiveness.

Method

Participants

Eligible participants were undergraduate students attending Laurentian University in Sudbury, Ontario, who were fluent in English and who had internet access. Students receiving in-person counselling at the time of the study were allowed to participate. A total of 249 undergraduate students initially enrolled in the study ranging in age from 17 to 59 years, with an average age of 25 and a standard deviation of 9.7 years. Of this preliminary group, the majority were females (n = 206, 82.7%), while males accounted for 14.9% of the sample (n = 37). One student identified as non-binary, 2 students identified as trans male, and 3 did not identify their gender. A total of 83.1% (n = 206) of this initial group were registered as full-time students, with the majority being psychology majors (34%, n = 85), followed by biomedical biology (5.2%, n = 13), nursing (5.2%, n = 13), social work (5.2%, n = 13), and Indigenous social work (4%, n = 10) as the most predominant majors. A total of 41% (n = 103) were first year students, 27% (n = 68) were second year, 19.3% (n = 48) were third year, and 12% (n = 30) were fourth year students.

The final sample included those students who fully completed the baseline assessments and who reported using their assigned app at least 4 times over the entire 6-week study. This final sample consisted of 77 students ranging in age from 17 to 53 years, with an average age of 26.7 and a standard deviation of 9.9 years. Most of the participants in the final sample were psychology majors (40.3%, n = 31), followed by biomedical biology (7.8%, n = 6), Indigenous social work (6.5%, n = 5), and pharmaceutical chemistry (5.2%, n = 4) as the most predominant majors. Table 4 details the participant demographics of the final sample.

Table 4

Participant Demographics of the Final Sample (N = 77)

Variables	Frequency, n (%)
Age (years)	
17	1 (1.3)
18	10 (13)
19	12 (15.6)
20	13 (16.9)
21	5 (6.5)
23	2 (2.6)
24	1 (1.3)
25 to 53	33 (42.9)
Year in School	
First-year undergraduate	33 (42.8)
Second-year undergraduate	15 (19.5)
Third-year undergraduate	17 (22.1)
Fourth-year undergraduate	12 (15.6)
Enrollment	
Full-time student	62 (80.5)
Part-time student	15 (19.5)
Gender	
Female	59 (76.6)
Male	17 (22.1)
Trans male	1 (1.3)

Materials

Demographic Questionnaire

A demographic questionnaire was developed for this study that included questions about

age, program of study, indication of mental health difficulties, and past or current involvement

with in-person counselling and/or use of mobile apps to help with mood, feelings, or emotions

(See Appendix A).

Hospital Anxiety and Depression Scale (HADS)

The HADS is a brief measure of the cognitive and emotional aspects of anxious and

depressive distress that has been validated for use in student populations (McCloud et al., 2020).

There are 7 items scored from 0 to 3 on both the anxiety (HADS-A) and depression (HADS-D)

subscales, yielding a possible range of 0 to 21 for each (McCloud et al., 2020). In the original

publication, scores between 0-7 on either subscale suggested 'normal' levels of anxiety and/or

depression, scores between 8-10 'suggested the presence of anxiety and/or depression', and

scores of 11 or above indicated the 'probable presence ('caseness') of anxiety and/or depression'

(Zigmond & Snaith, 1983). In an effort to capture the true presence of anxious and depressive

distress, the current study dichotomized the categorization system with scores between 0-7

reflecting 'normal' levels of anxious and depressive distress, and scores between 8-21 reflecting

the presence of anxious and depressive distress. Examples of questions from the HADS anxiety

subscale include, "I feel tense or wound up", and "Worrying thoughts go through my mind"

(Zigmond & Snaith, 1983). Examples of questions from the HADS depression subscale include,

"I feel cheerful", and "I feel as if I am slowed down" (Zigmond & Snaith, 1983).

Specificities and sensitivities for the HADS are usually reported to be 80% or higher in

UK-based research (McCloud et al., 2020). A previous study did not reveal any differences

between online and pen-and-paper versions of the scale (Whitehead, 2011). Although a

minimally clinically important difference (MCID) has not been established for the HADS in the

general population, estimates obtained from trials of those with chronic pulmonary obstructive

disorder and cardiovascular disease have suggested that a change in score of 1.5 (Bhandari et al.,

2013; McCloud et al., 2020) to 1.7 points is generally accepted as the MCID (Lemay et al.,

2019). Consistent with recent research conducted by McCloud et al. (2020) the current study

used the MCID of 1.5 to represent the smallest worthwhile improvement in anxious and/or

depressive distress.

App Usage Questionnaire

A brief app usage questionnaire was developed for this study that included questions about participants' use of their assigned app during the previous two weeks. Participants were also asked if they had experienced any stressful events in the prior two weeks and if they had used their assigned app to help them cope (See Appendix B, C and D).

Mobile Applications

DARE App. The DARE App is a free American developed mHealth app that is described on its website, www.dareresponse.com, as an evidence-based training program to help people overcome anxiety, panic attacks, worry, and insomnia (The DARE App, n.d.). According to the website (found under 'Advisory Board'), the DARE app claims to be rooted in Mindfulness Based Stress Reduction (MBSR), Mindfulness Based Cognitive Therapy (MBCT), and Acceptance and Commitment Therapy (ACT) (The DARE App, n.d.). The DARE app offers audio clips providing psychoeducation, guided trainings (i.e., meditation, breathing exercises, affirmations), and soothing background noise (i.e., nature sounds, campfire) (The DARE App, n.d.; One Mind PsyberGuide, n.d.) to be used at the discretion of the user. Additional features such as 'Rapid Relief' audios, live group zoom calls, and extra support with a 'DARE buddy' are available for purchase either through an annual subscription (CAD $92.99) or monthly fee (CAD $16.99) (The DARE App, n.d.). The content of the DARE app has reportedly been written, reviewed, and analyzed by mental health and medical professionals who make up the DARE advisory board (The DARE App, n.d.; One Mind PsyberGuide, n.d.).

MindShift App. MindShift is a free Canadian developed mHealth app that is described on its website, www.anxietycanada.com, as using evidence-based strategies based on Cognitive Behavioural Therapy (CBT) to help alleviate symptoms of anxiety (Anxiety Canada, n.d.). It

claims to teach relaxation and mindfulness to help develop more effective ways of thinking and taking charge of anxiety (Anxiety Canada, n.d.). It contains information about common sources and symptoms of worry, anxiety, and panic, and provides a checklist to help users determine the types of anxiety they most commonly face (One Mind PsyberGuide, n.d.). At their discretion, users can access guided relaxation exercises, basic cognitive behavioural therapy techniques for anxiety (i.e., belief experiments), and create individualized coping plans for common anxiety-provoking situations (Anxiety Canada, n.d.). The app website claims to provide tools to tackle worry, panic, perfectionism, social anxiety, and phobias. It also offers a community forum to enable peer-to-peer support (Anxiety Canada, n.d.). The MindShift app has a scientific advisory committee, a youth committee, and a board of directors who help develop content (Anxiety Canada, n.d.). The MindShift app reportedly partners with several mental health and addictions agencies (Anxiety Canada, n.d.).

Stresscoach App. Stresscoach (formerly Pocketcoach), is an Austrian developed self-help app that according to the website, www.stresscoach.app, is designed to manage stress and anxiety using Cognitive Behavioural Therapy (CBT) and mindfulness. The app consists of two main treatment components; long-term behavioural therapy through a 6-week course that covers the fundamentals and treatments for anxiety and stress for those needing more intensive interventions (i.e., topics covering anxiety in the body, safety behaviours, and breathing); and short exercises in the form of relaxation audios for those needing quick, in the moment interventions (i.e., breathing, and guided audios lasting between 5-15 minutes) (Stresscoach, n.d.; One Mind PsyberGuide, n.d.). The content on Stresscoach is reportedly developed and maintained by mental health professionals in the field of psychology (Stresscoach, n.d.). While Stresscoach is advertised as free with in-app purchases, payment is requested to continue using

the app after the first three uses. Users can either purchase an annual subscription (USD $69.99)

or pay a monthly fee (USD $9.99) (Choosing Therapy, n.d.). The app developer provided free

use of the Stresscoach app to participants of the current study.

Coloring Book for Adults App. The Coloring Book for Adults app is a free American

developed colouring game app with hundreds of free high-quality pictures and images

(https://play.google.com/store/apps/details?id=net.applabsinc.android_enchantedforest&hl=en_C

A&gl=US). Colouring categories include mandalas, animals, portraits, and flowers. While the

app acknowledges that colouring is relaxing and stress reducing, the app is advertised as

entertainment (Coloring Book for Adults, n.d.).

Procedure

Mobile mental health applications for the present study were chosen based on internet

searches for "free anxiety relief apps". At the time of the current study, an initial Google search

produced 44 potential apps on the first three Google pages alone, many of which were found in

articles that listed the "top" apps for treating anxiety. A further search of the Google Play store

produced 30 potential apps. Apps were further selected based on the following criteria: 1)

marketed for specifically treating anxiety; 2) evidence-based; 3) primarily marketed as free to

use but could have in-app purchases; 4) user ratings of 4 out of 5 stars or higher; 5) could be used

for at least 6 weeks; 6) could be used by people 17 years of age and older; 7) privacy policies

clearly outlined; 8) available for use on Android or Apple devices. The top three search results

that met all the criteria outlined above at the time of the current study were DARE, Mindshift,

and Stresscoach (formerly Pocketcoach). A fourth app was added as an active smartphone-based

control to account for a potential digital placebo effect, as is consistent with recommendations

put forth by McCloud and colleagues (2021). Following internet searches for an entertainment

and leisure app, the Coloring Book for Adults app was chosen to serve as the smartphone-based control as it is easy to use and available for both Android and Apple devices.

Following approval from Laurentian University's Research Ethics Board (REB) (See Appendix E) participants were recruited between September 2021 and December 2022 via social media advertisements and recruitment pitches to undergraduate classes. Incentives for participation were offered in the form of extra course credit and gift card draws. All relevant information and questionnaires were made available to students online through an electronic research system (REDCap). Randomized numerical student identification was used to track results, and no student names were used. Students had the option of providing their email address to be entered into the incentive draws.

Participants completed the demographic questionnaire and the Hospital Anxiety and Depression Scale (HADS) as baseline measures and were then randomly assigned to one of three treatment conditions (DARE, Mindshift, or Stresscoach) or the control group (Coloring Book for Adults). Participants were then asked to download their assigned app from iTunes or Google Play and to use it at least once a week for 6 weeks. While low, this level of app usage is consistent with adherence levels utilized by McCloud and colleagues (2020), and it was thought to be a reasonable and achievable usage schedule for busy university students. Every two weeks participants were sent a confidential email reminder to complete the brief app usage questionnaire, with a 72-hour window to do so. At the end of the 6-week trial participants were asked to complete the HADS as a follow-up measure of app effectiveness.

Operational Definition of Dependent Variables

For the purposes of the current study, the experience of anxiety and depression being measured will be referred to as psychological anxious distress and psychological depressive

distress, respectively. These definitions are intended to capture the psycho-social cognitions (thoughts) and emotions (feelings) underlying the psychological response to stressors, rather than a DSM-5 based psychiatric diagnosis of anxiety and/or depression as this is beyond the scope of the current study.

<div align="center">

Results

</div>

Attrition and Adherence

Attrition was defined and measured by participant discontinuation of the study at any point during the 6-weeks of the study. Following the first 2 weeks of using the assigned apps, substantial participant attrition was observed among the initial participants with a 43.3% (n = 29) decline in the DARE app condition, a 44.3% (n = 31) decline in the Mindshift app condition, a 54.3% (n = 25) decline in the Stresscoach app condition, and a 41.3% (n = 26) decline in the digital control condition (Coloring Book for Adults app). Over the course of the first 2 weeks, 71.8% (n = 107) of the remaining participants reported that they had experienced a 'particularly stressful situation', and 52.3% (n = 56) of these participants noted that they had used their assigned app to help them cope with the situation.

By week 4 of the study, attrition continued with a further 29% (n = 11) decline in the DARE app condition, a 30.8% (n = 12) decline in the Mindshift app condition, a 33.3% (n = 7) decline in the Stresscoach app condition, and a lesser decline of 19% (n = 7) in the digital control condition (Coloring Book for Adults app). Between weeks 2 and 4 of the study, 71.7% (n = 76) of the remaining participants reported that they had experienced a 'particularly stressful situation', and 51.3% (n = 39) of these participants noted that they had used their assigned app to help them cope with the situation.

By the end of the 6 weeks, a further decline of 14.8% (n = 4) of participants was observed in the DARE app condition, a 22.2% (n = 6) decline was observed in the Mindshift app condition, a 7.1% (n = 1) decline was observed in the Stresscoach app condition, and a 33.3% (n = 10) decline was observed in the digital control condition. Between weeks 4 and 6 of the study, 75% (n = 66) of the remaining participants reported that they had experienced a 'particularly stressful situation', and 48.4% (n = 32) of these participants noted that they had used their assigned app to help them cope with the situation.

By the end of the 6-week trial, all conditions retained approximately 1/3 of their participants; DARE = 34.3%, n = 23; Mindshift = 30%, n = 21; Stresscoach = 28.3%, n = 13; Coloring Book for Adults [digital control] = 31.7%, n = 20. These participants made up the final sample ($N = 77$). Figure 1 depicts the flow of participants through the study, and Figure 2 depicts student attrition by self-identified mental health issue.

Figure 1

Flow of Participants Through the Study
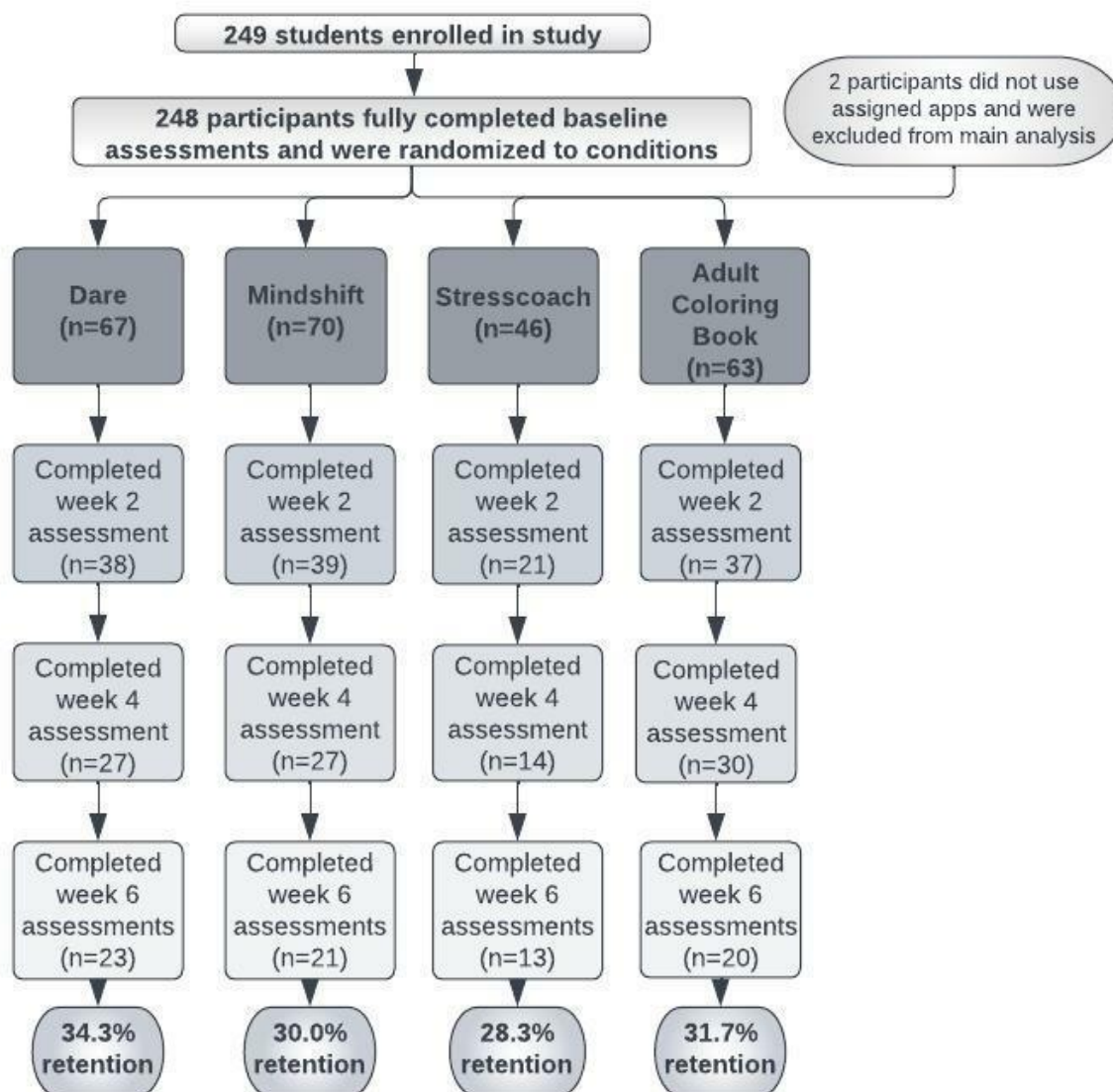
Figure 2

Attrition by Self-Identified Mental Health Issue (Preliminary Sample, N = 248; Final Sample, N

= 77)
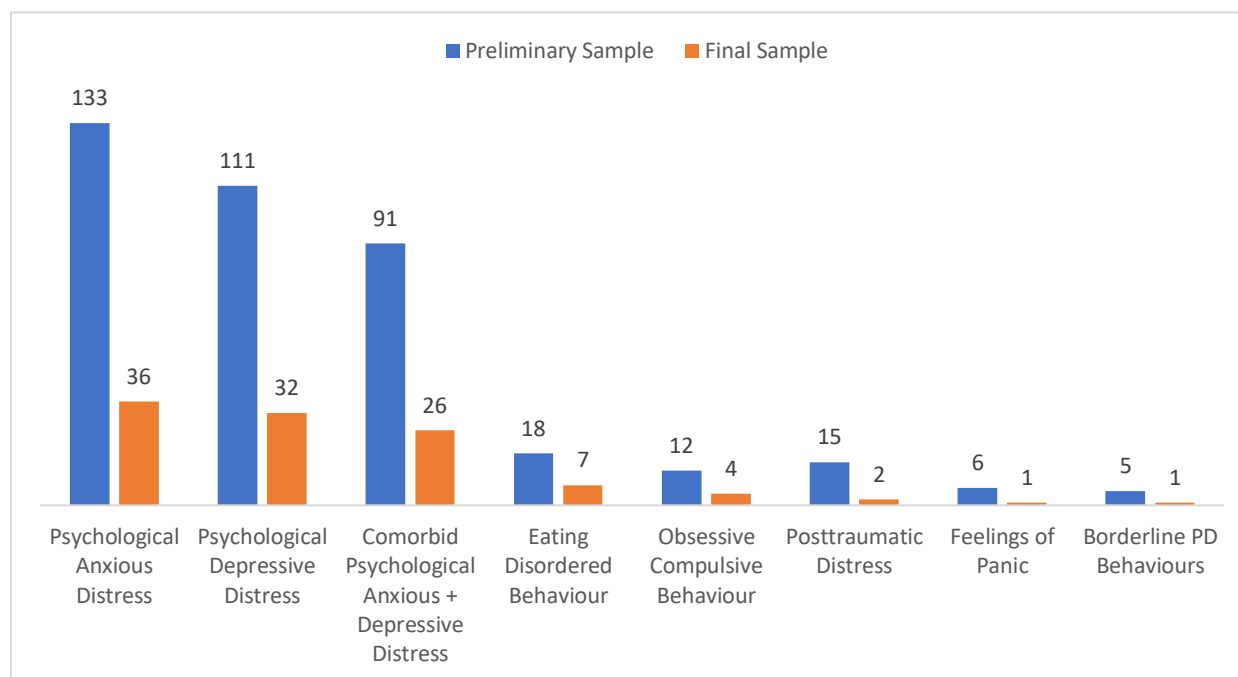
The greatest amount of attrition occurred among those with psychological anxious

distress (73%, n = 97) and psychological depressive distress (71.2%, n = 79). Not depicted in

Figure 2 is the attrition of those with ADHD type behaviours (69%, n = 9), substance abuse

(60%, n = 3), ASD type behaviours (50%, n = 1), and dissociative behaviours (66.6%, n = 2).

Among those who completed the entire study, 75.3% (n = 58) reported that they had

experienced a 'particularly stressful situation' in the first two weeks, and 55.2% (n = 32) of these

participants indicated that they had used their assigned app to help them cope. Between weeks 2

and 4, the same number of participants (75.3%, n = 58) reported that they had experienced a

'particularly stressful situation', and 56.9% (n = 33) of these participants noted that they had

used their assigned app to help them cope. Between weeks 4 and 6, 77.9% (n = 60) of the final

participants noted that they had experienced a 'particularly stressful situation', and 51.7% (n =

31) indicated that they used their assigned app to help them cope. Figure 3 shows the app usage

of the final sample across the 6 weeks of the study.

Figure 3

App Usage of the Final Sample (N = 77)
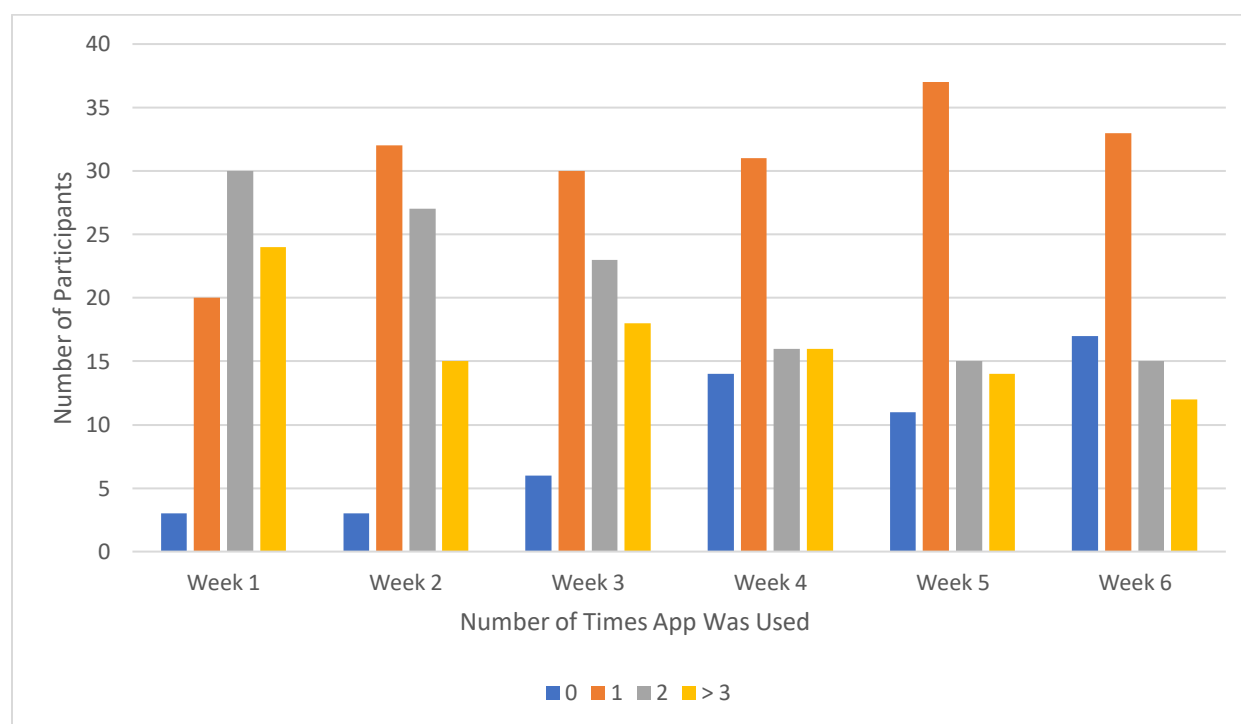
As can be seen in Figure 7, the most common app usage schedule was once a week.

Despite this, only 54.7% (n = 41) of participants met the adherence criteria of consistently using

their assigned app at least once a week for the entire 6 weeks of the study. Of those who

reportedly adhered to this schedule, 31.7% (n = 13) were assigned to the DARE app, 26.8% (n =

11) were assigned to the Mindshift app, 24.3% (n= 10) were assigned to the digital control

(Coloring Book for Adults), and 17.1% (n = 7) were assigned to Stresscoach.

Due to limited app usage among the participants, the definition of app adherence for the

purposes of the current study was reduced from once a week to just '4 or more times' over the

course of 6 weeks. This decision was made to maintain an adequate sample size for comparison

purposes.

Baseline Data

Table 5 shows the number of participants in the final sample who self-reported

psychological anxious distress and/or psychological depressive distress at baseline assessment.

Results include responses to open-ended mental health enquiries on the demographic

questionnaire, as well as standardized HADS scores. Students did not require a formal diagnosis

to report psychological difficulties.

Table 5

Self-Reported Mental Health Issues Identified at Baseline (N = 77)

	Baseline Measures	
Mental Health Issue	**Demographic Questionnaire**	**HADS**
Psychological Anxious Distress	46.8% (n = 36)	59.7% (n = 46)
Psychological Depressive Distress	41.6% (n = 32)	20.7% (n = 16)
Other Psychological Distress*	29.9% (n = 23)	n/a

*Includes self-reported comorbidities with psychological anxious and depressive distress

Table 6 shows the types of mobile apps previously used by participants in the final

sample. A total of 35.1% (n = 27) had used one or more mobile apps of any kind at some point in

time to help with their mood, feelings, or emotions.

Table 6

Type and Frequency of Apps Previously Used (N=77)

mHealth Apps	Frequency, n	Other Apps	Frequency, n
Aloe Bud	1	Instagram	1
Bearable	1	Music App	1
Be Calm with Tati	1	Spotify Music	3
Calm	2	Spotify Podcasts	1
Clear Fear	1	TikTok	1
Daylio	1	Wattpad	1
Fabulous	1	WhatsApp	1
Finch	2	Could Not Recall	2
Headspace	6	**TOTAL OTHER APPS**	**11**
Mindshift	1		
Mood Notes	1		
Motivation	1		
Pacifica	1		
Remente	1		
Sanity and Self	1		
Sanvello	1		
Stop, Breathe & Think	1		
Smiling Mind	1		
Well Track	1		
TOTAL mHEALTH APPS	**26**		

Of the final group of participants, 9.1% (n = 7) were currently seeing a professional to help with their mood, feelings, or emotions. Of those participants, 85.7% (n = 6) were receiving this intervention virtually. Only 2 participants indicated that they had engaged in counselling at some point *and* had also used an app of any kind at some point to help with their mood, feelings, or emotions. Of those participants, 1 found professional counselling more effective than an app, while the other felt that they were both effective. Nonetheless, both participants expressed a preference for professional counselling, regardless of the outcome.

The final data set was cleaned and examined for missing information and analyzed using IBM SPSS Statistics 28.0 software. Two participants left one item blank on the baseline HADS administration which were replaced using the subscale half mean approach as recommended by Bell and colleagues for HADS missing data (2016).

Intervention Effects

A two-way repeated measures multivariate analysis of variance (MANOVA) with app group (DARE, Mindshift, Stresscoach, Coloring Book) and time (baseline/follow-up) as the independent variables and the two types of psychological distress as the dependent variables (psychological anxious distress and psychological depressive distress) was used to examine the influence of app group over time. The correlations of the dependent variables suggested a weak but acceptable correlation at .30. Bartlett's test of sphericity was statistically significant (x^2 = 6.58, df = 1, p < .05) indicating that the correlation of the dependent variables was sufficient to support the MANOVA. Box's test of the equality of the variance-covariance matrices was non-significant [Box's M = 41.556, $F(30, 9778.821)$ = 1.237, p = .175], suggesting that the matrices were equal. Levene's test of equality of variance produced non-significant results suggesting equal variance between the levels of the independent variables (*p-values* > .05).

Descriptive statistics, histograms and Q-Q plots were examined to assess normality of the data. Examination of Mahalanobis distance suggested that there were no outliers in the data (df = 4, MD = 16.86). Based on skewness and kurtosis, the assumption of normality was met for the dependent variable of psychological anxious distress (HADS-A) on both baseline (skewness = .22, kurtosis = -.82) and follow-up (skewness = .38, kurtosis = .00) distributions. The Shapiro-Wilk test of normality also showed normality of the distribution for HADS-A at both baseline (W = .97, p = .06) and follow-up (W = .98, p = .28).

Based on skewness and kurtosis, the assumption of normality was also met for the dependent variable of psychological depressive distress (HADS-D) on both baseline (skewness = .84, kurtosis = .02) and follow-up (skewness = .49, kurtosis = -.55) distributions. However, the Shapiro-Wilk test of normality showed that the distribution of psychological depressive distress departed from normality at baseline ($W = .92$, $p < 0.001$) and follow-up ($W = .96$, $p = 0.01$). Since the Shapiro-Wilk test is sensitive to even slight departures from normality (Meyers et al., 2017), and given that skewness and kurtosis were within range, it was assumed that the assumption of normality was met for psychological depressive distress. However, given the potential violation of normality, the multivariate effect was examined using Pillai's Trace as it is more robust with respect to violations of this assumption than the other multivariate tests of statistical significance (Meyers et al., 2017).

For the main hypothesis, it was predicted that participants in the treatment conditions (mHealth apps: DARE, Mindshift, Stresscoach) would have lower levels of psychological anxious distress (HADS-A) at the 6-week follow-up compared to those in the digital control group (leisure app: Coloring Book for Adults). The second hypothesis similarly predicted that participants in the treatment conditions would have lower levels of psychological depressive distress (HADS-D) at the 6-week follow-up compared to those in the digital control group.

The multivariate interaction effect of time x app group was non-statistically significant, Pillai's Trace = .024, $F(6, 146) = .290$, $p = .941$. However, the multivariate main effect of app group was statistically significant, Pillai's Trace = .231, $F(6, 146) = 3.18$, $p = .006$. App group accounted for approximately 23% of the multivariate variance ($\eta_p^2 = .231$). The multivariate main effect of time was marginally statistically significant, Pillai's Trace = .065, $F(2, 72) = 2.49$,

$p = .089$; the variable of time accounted for approximately 7% of the multivariate variance ($\eta_p^2 = .065$).

Univariate results indicated that the effect for the dependent variable of psychological anxious distress was not significant ($F(1,73) = .345$, $p = .559$). The effect for the dependent variable of psychological depressive distress was found to be statistically significant ($F(1,73) = 4.378$, $p < .05$). Psychological depressive distress accounted for approximately 6% of the variance ($\eta_p^2 = .057$).

Pairwise comparisons showed that the Mindshift app was statistically different from the Stresscoach and Coloring Book App on the dependent variable of psychological depressive distress. Table 7 outlines the means and standard deviations for all app groups on the HADS; Table 8 shows the mean difference of the Mindshift app.

Table 7

Post Hoc Comparisons of the HADS Across App Groups

Psychological Anxious Distress	Means	Standard Deviation
Dare	9.1	4
Mindshift	7.4	4.7
Stresscoach	10.3	4.2
Coloring Book	10.4	4.3
Psychological Depressive Distress	**Means**	**Standard Deviation**
Dare	5.3	2.9
Mindshift	3.2	2.5
Stresscoach	7.4	4
Coloring Book	5.8	3.4

Based on estimated marginal means

Table 8

Post Hoc Comparisons of the App Groups on Psychological Depressive Distress

Measure	Condition (App)		Mean Difference	Sig.
Psychological Depressive Distress	**Mindshift**	**Dare**	-2.112	.094
		Stresscoach	-4.209*	<.001
		Coloring Book for Adults	--2.536*	.032

Based on estimated marginal means
* The mean difference is significant at the .05 level

With regard to the marginal effect of time, pairwise comparisons revealed that there was a statistically significant difference between baseline and follow-up scores on the dependent variable of psychological depressive distress (*p* = .040), irrespective of app, showing an increase in scores. Table 9 shows this difference. Table 10 shows means and standard deviations for all conditions (app x time); Figure 4 depicts the app group by time trends.

Table 9

Pairwise Comparisons of Baseline and Follow-up HADS Scores

Psychological Anxious Distress	Means	Standard Deviation	Mean Difference	Sig.
Baseline	9.5	4.7	.240	.559
Follow-up	9.2	4.2		
Psychological Depressive Distress	**Means**	**Standard Deviation**	**Mean Difference**	**Sig.**
Baseline	5.1	3.3	-.698*	.040
Follow-up	5.8	3.5		

Based on estimated marginal means
* The mean difference is significant at the .05 level

Table 10

Means and Standard Deviations of HADS Scores Across Conditions (N = 77)

	HADS-A		HADS-D	
	Baseline	Follow-up	Baseline	Follow-up
Condition (App)	*M* (SD)	*M* (SD)	*M* (SD)	*M* (SD)
DARE	9.5 (4.4)	8.8 (3.6)	5.2 (2.7)	5.5 (3.2)
Mindshift	7.5 (4.6)	7.3 (4.8)	2.8 (1.9)	3.7 (2.9)
Stresscoach	10.3 (4.5)	10.4 (4.1)	7.2 (3.9)	7.6 (4.4)
Coloring Book	10.5 (4.9)	10.4 (3.7)	5.2 (3.6)	6.4 (3.1)

HADS-A: Hospital Anxiety and Depression Scale-Anxious Distress Subscale
HADS-D: Hospital Anxiety and Depression Scale-Depressive Distress Subscale

Figure 4

Pairwise Comparisons of the App Groups on Psychological Depressive Distress
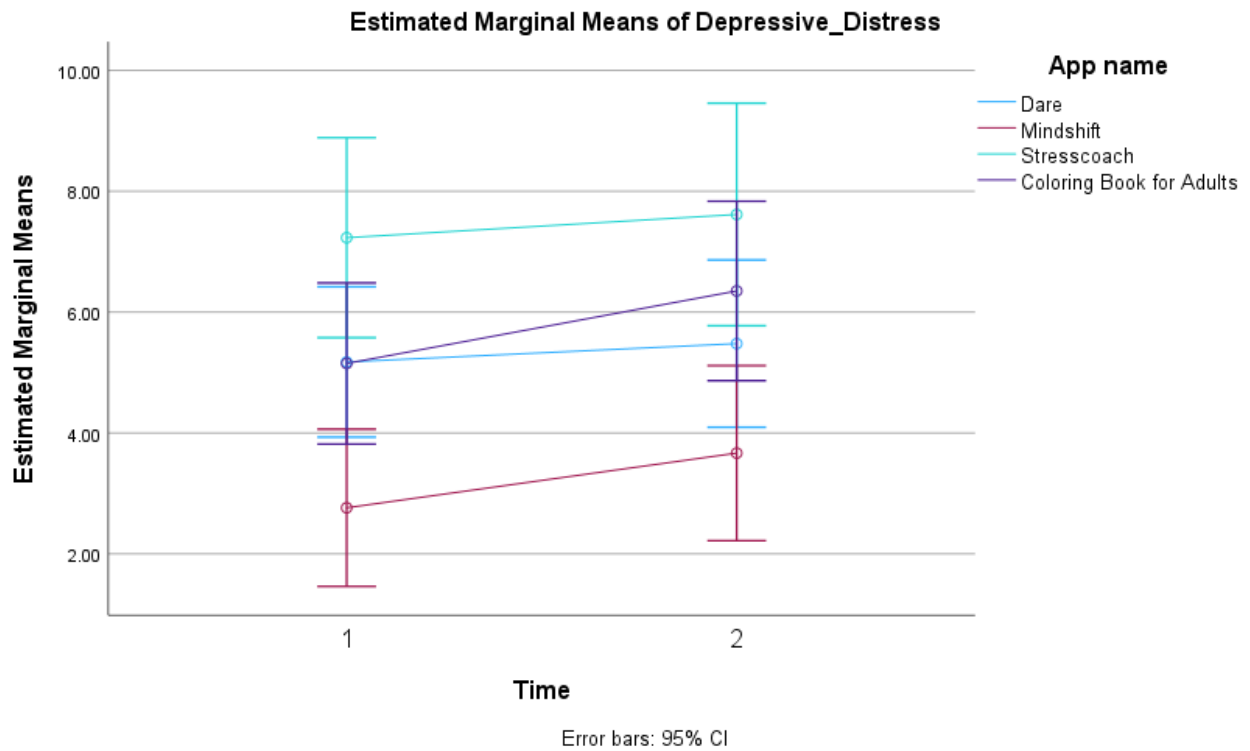
To better understand levels of psychological anxious distress over time, irrespective of app, a repeated measures analysis of variance (ANOVA) was conducted with baseline category of psychological anxious distress (anxious distress/no anxious distress) and time (baseline/follow-up) as the independent variables, and psychological anxious distress as the dependent variable. This was done to separate the participants into "anxious and non-anxious" categories to examine the effect of time on each category.

The results showed a statistically significant change from baseline levels of psychological anxious distress over time irrespective of app condition ($F(1, 75) = 25.328$, $p < .001$). Baseline category of psychological anxious distress accounted for approximately 25% of the variance ($\eta_p^2 = .25$). Pairwise comparisons revealed that participants who were in the "non-anxious" category at baseline ($M = 4.8$, $SD = 1.9$) showed an increase in psychological anxious distress at follow-up ($M = 6.6$, $SD = 3.3$). Participants who were in the "anxious" category at baseline ($M = 12.4$, $SD = 3.2$) showed a decrease in psychological anxious distress at follow-up ($M = 10.7$, $SD = 3.9$). These changes exceeded the minimal clinically important difference (MCID) of the HADS (MCID = 1.5) (McCloud et al., 2020). Figure 5 depicts this trend.

Figure 5

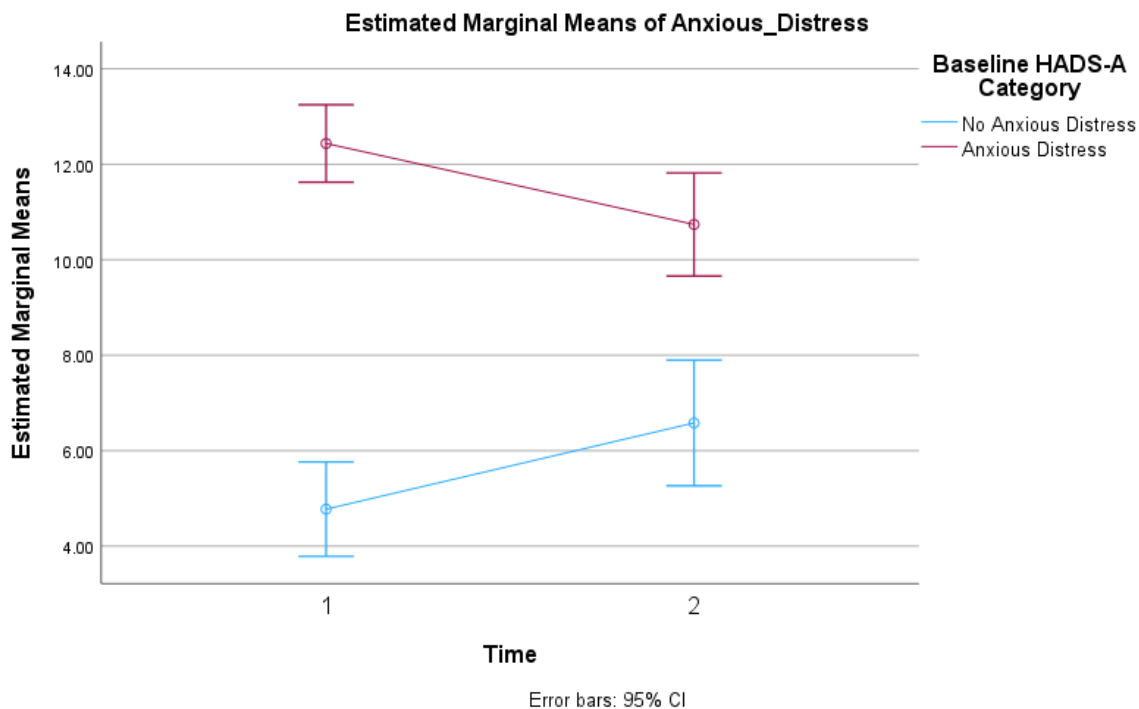*Trajectory of Baseline HADS-A Categories*

To better understand levels of psychological depressive distress over time, irrespective of app, a repeated measures analysis of variance (ANOVA) was conducted with baseline category of psychological depressive distress (depressive distress/no depressive distress) and time (baseline/follow-up) as the independent variables, and psychological depressive distress as the dependent variable. This was done to separate the participants into "depressive and non-depressive" categories to examine the effect of time on each category.

The results showed a statistically significant change from baseline levels of psychological depressive distress over time irrespective of app condition ($F(1, 75) = 6.87$, $p = .011$). Baseline category of depressive distress accounted for approximately 8% of the variance ($\eta_p^2 = .08$).

Pairwise comparisons revealed that participants who were in the "non-depressive" category at baseline (M = 3.5, SD = 1.9) showed an increase in psychological depressive distress at follow-up (M = 4.6, SD = 2.9). Participants who were in the "depressive" category at baseline (M = 10.1, SD = 1.9) did not show a change in levels of psychological depressive distress at follow-up (M = 9.2, SD = 3.4). Figure 6 depicts this trend.

Figure 6

Trajectory of Baseline HADS-D Category
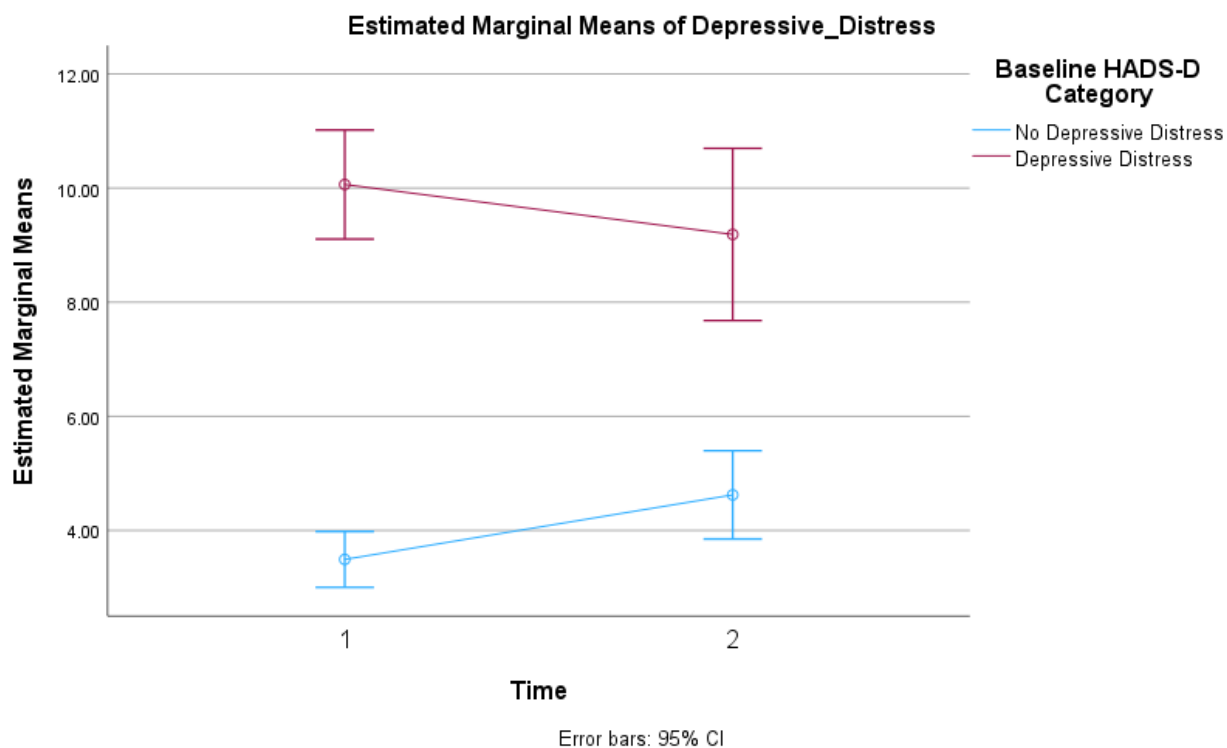
Adherence vs. Non-adherence in Study Completers

An independent samples t-test was conducted to compare baseline levels of psychological anxious distress between participants who completed the study and met app adherence criteria (at

least 4 times in 6 weeks) ($M = 9.7$, $SD = 4.7$) and those who completed the study but did not comply with app adherence ($M = 8.8$, $SD = 4.6$). The difference between the groups was not significant, $t(73) = -.805$, $p = .423$. Likewise, an independent samples t-test was conducted to compare baseline levels of psychological depressive distress between those who completed the study and met app adherence criteria ($M = 5$, $SD = 3.3$) and those who completed the study but did not comply with app adherence ($M = 4.4$, $SD = 3$). The difference between the groups was not significant, $t(73) = -.795$, $p = .429$.

Study Completers vs. Non-completers

Of the 77 participants who completed the study, the majority were female (76.6%, $n = 59$). Those who completed the study were also predominantly full-time (80.5%, n = 62), first-year students (42.8%, $n = 33$), in the 18- to 20-year-old age range (45.5%, $n = 35$).

Of the 169 participants who did not complete the study, the majority were female. Most of the participants who did not complete the study were in the 18- to 20-year-old age range. The majority of non-completers were in their first (39.6%, n = 67) and second year (30.8%, n = 52) of studies.

Independent samples t-tests were conducted to compare baseline levels of psychological anxious distress and psychological depressive distress between participants who completed the study and those who did not. On average, participants who elected to drop-out of the study had higher levels of psychological anxious distress ($M = 11.1$, $SD = 4.7$) than those who completed the study ($M = 9.4$, $SD = 4.7$), $t(244) = 2.79$, $p = .006$. On average, participants who dropped-out of the study also had higher levels of psychological depressive distress ($M = 6$, $SD = 3.7$) than those who completed the study ($M = 4.9$, $SD = 3.3$), $t(244) = 2.21$, $p = .028$.

Discussion

The current study sought to evaluate the efficacy of three publicly available mobile mental health applications (mHealth apps) in reducing levels of psychological distress in university students. Since "anxiety" has been identified in the literature as the most prominent mental health issue impacting university students (ACHA 2019 & 2022; Auerbach et al., 2016) there was a specific interest in the ability of these apps to reduce anxious distress. Moreover, since "anxiety" and "depression" are highly comorbid (Bakker et al., 2016) there was also an interest in the ability of these apps to reduce levels of depressive distress. The mHealth apps chosen for the current study were DARE, Mindshift, and Stresscoach as these apps were marketed for reducing levels of "anxiety" and were advertised as free to use. Using a random control design, the mHealth apps were compared to an active smartphone-based control in the form of a leisure based colouring app in order to rule-out a potential digital placebo effect, as recommended in previous research by McCloud and colleagues (2020).

Mental Health Terminology in the Literature

Before discussing the results of the current assessment, it is important to acknowledge the numerous terms used throughout the literature to describe the mental health challenges faced by university students. These terms include anxiety, depression, major depressive disorder, psychological distress, mental disorder, mental illness, psychological problems, emotional distress, and impairment to name a few. The number of terms used becomes confusing and problematic as they are not synonymous and represent different theoretical constructs, ranging from psychological reactions to events, to developmental young adult issues, to the heavily utilized disease model. The latter approach is based on a psychiatric DSM-5 framework that utilizes the terms "anxiety" and "depression", both of which assume a DSM-5 diagnosis.

However, most researchers rely on self-report and cannot confirm a psychiatrically based diagnosis. Without a DSM-5 diagnosis the underlying reasons for psychological distress are unclear and cannot be assumed. As such, it becomes difficult to parse out the actual issues being measured and studied in the research.

The significance of clarifying terminology becomes clear when we consider that the research and theoretical basis behind mental health apps is not medically based. Apps cannot possibly diagnose psychiatric disorders, nor can they confirm pre-existing diagnoses. Therefore, a psycho-social approach must be assumed, and the focus of mental health apps should be on the thoughts and emotions of the intended population, not diagnostic criteria. To this end, the current study has adopted the terms *psychological anxious distress* and *psychological depressive distress* to elucidate the fact that the difficulties being measured and studied are not diagnostic in nature, but rather, moment-in-time states of psychological distress reflecting anxious and depressive thoughts and emotions.

Principal Findings

The current study hypothesized that a 6-week trial of the mHealth apps would result in significant reductions in levels of psychological anxious and depressive distress as measured by the Hospital Anxiety and Depression Scale (HADS), compared to the smartphone-based control. Results of a MANOVA showed multivariate main effects for app group and marginal multivariate main effects for the passage of time, but not for their interaction. Univariate results suggested that the Mindshift app group was statistically different from the Stresscoach and Colouring Book app on the dependent variable of psychological depressive distress. These results showed that the Mindshift app group started the study with the lowest levels of depressive distress and ended the study with the lowest levels of depressive distress. Participants in the

Mindshift app group did not possess any demographic characteristics that set them apart from the other app groups, indicating that this difference was simply a result of randomization. With regard to the marginal multivariate effect of time, univariate results suggested that over time, and irrespective of app, levels of depressive distress increased overall. Despite this increase, participants did not move into a different category of distress, and this change did not exceed the minimal clinically important difference (MCID) of the HADS, suggesting that this was not an important change in the participants' level of psychological depressive distress. This result may, however, provide support for increases in students' psychological distress as they progress through their studies, which has been reported in the literature (Bewick et al., 2010).

It is important to note that the sample used in the current study included participants who were not experiencing psychological distress. As a result, additional analyses were done to separate participants into two distinct categories within each of the dependent variables (anxious and non-anxious/depressive and non-depressive) in an effort to better understand levels of psychological anxious and depressive distress over time, irrespective of app. To this end, two separate repeated measures analysis of variance (ANOVAs) were conducted with each dependent variable, using 'baseline categories' of psychological anxious and psychological depressive distress as independent variables. Results of the ANOVA for psychological anxious distress showed a statistically significant change from the baseline category of psychological anxious distress over time irrespective of app condition. Participants who were "non-anxious" at baseline showed an increase in psychological anxious distress at follow-up. Participants who were in the "anxious" category at baseline showed a decrease in psychological anxious distress at follow-up. While these changes did not move participants into a different category of distress,

they did exceed the MCID of the HADS, suggesting an important change in the participants' levels of psychological anxious distress over time, regardless of the app used.

Participants who were in the "non-depressive" category at baseline showed an increase in depressive distress at follow-up, regardless of the app used. While significant, this change did not move participants into a different category of distress, and it did not exceed the MCID of the HADS, suggesting that this was not an important change in the participants' level of psychological depressive distress. Participants who were in the "depressive" category at baseline did not show a change in levels of psychological depressive distress at follow-up. These results suggest that the 'room you have to go' dictates change, resulting in regression to the mean; low cases typically have nowhere to go but up, and high cases typically have nowhere to go but down. These results also underscore the fact that baseline level distress is an important factor to consider in mental health interventions as those who demonstrate more extreme distress, whether high or low, are more likely to experience a change over time.

For those participants who experienced a reduction in problematic psychological anxious distress at follow-up, this may suggest an improvement in anxious thoughts and feelings on their own over time. For those who reported increases in psychological anxious and depressive distress at follow-up, this may reflect situational factors, including the COVID-19 pandemic, or once again, it may provide support for increases in students' psychological distress as they progress through their studies. Another alternative explanation may be the impact of the observer effect. The effect of enrolling in this study may have raised participant awareness of their mental health, either causing them to realize they were struggling (resulting in a self-identified increase in distress) or causing them to realize their distress was not as severe as initially reported (resulting in a self-identified decrease in distress).

While the results of this study should be viewed with some degree of caution, they do not support the findings of previous studies that have demonstrated the effectiveness of mHealth apps in reducing levels of psychological anxious and depressive distress in university students (Harrer et al., 2018; Lee & Jung, 2018; McCloud et al, 2020; Ponzo et al., 2020). From a statistical standpoint, the results of the current study do not support the evidence suggesting that mHealth apps are a promising alternative to traditional in-person interventions.

While many studies have reported statistically significant reductions in anxious and depressive distress among university students as a result of using mHealth apps, there are a small number that have reported mixed results. For example, in 2018, Bakker and colleagues found that students experienced statistically significant reductions in depression following a 4-week trial of mHealth apps compared to a waitlist control, but no reductions in anxiety compared to the waitlist. Lee and Jung (2018) found that while some aspects of emotional well-being improved among students following a 4-week trial of an mHealth app, no significant differences were found between the app group and a waitlist control for "depression" and "state anxiety".

The handful of studies that have reported mixed results pales in comparison to the high number of studies reporting statistically significant results. Nonetheless, given the newness of the mHealth app market and the uptake of this modality by citizens, governments, and agencies alike, it is important that research into this burgeoning industry continue; not only to hold app developers to account, but to protect the vulnerable individuals who may turn to this mode of intervention for help.

mHealth App Challenges

The results of this study were unexpected as the mHealth apps selected for the treatment conditions claimed to use evidence-based interventions to reduce psychological anxious distress

(i.e., CBT, mindfulness). The lack of app effectiveness observed in the current study may not be a direct result of the treatment modality in and of itself. It may more accurately reflect the inadequate research into the effectiveness of mHealth apps overall (Van Ameringen et al., 2017). Afterall, there are currently no standardized methods for assessing the efficacy of mHealth apps (Marshall et al., 2019a) and this lack of research-based evidence makes it difficult for consumers and professionals alike to know which mHealth apps are effective (Van Ameringen et al., 2017). This was indeed the case in the current study, as despite a seemingly thoughtful and systematic approach to selecting mHealth apps, there was little information on app effectiveness to help guide the search.

Further complicating the ability to evaluate and choose the most effective mHealth apps is the ever-changing app market. Apps are removed from the market approximately every 2.9 days (Van Ameringen et al., 2017). This not only impacts the ability to conduct research on app effectiveness, but it can also impact the user experience. The sudden removal of an mHealth app could have adverse effects on users who experience success with the app, whether actual or perceived. The current study was not spared from changes in the app market. During this short 6-week study, one of the apps changed its name (Stresscoach was originally Pocketcoach) and shortly thereafter, it was pulled from the Canadian app market due to a change in ownership. This had an impact on the sample size of the Stresscoach condition resulting in fewer participants within this group which may have impacted the ability to adequately evaluate the efficacy of this app. A further issue encountered with the Stresscoach app was lack of transparency regarding costs associated with use. Stresscoach was advertised as free to use, however, after 3 uses, payment was suddenly requested to continue using the app. This resulted in logistical issues and impacted participants' ability to use the app until a solution was found.

Thankfully, the app developer provided free use to participants of this study. However, participants were required to provide their email address to the developer in order to gain free access, which may have impacted students' willingness to continue with the study due to confidentiality concerns.

The lack of mHealth app effectiveness observed in the current study may in part be due to poor app adherence. Participants were asked to use their assigned app at least once a week in compliance with the app adherence schedule defined by the researchers. However, only 54.7% of participants reportedly adhered to this schedule, and unfortunately, there is no way to confirm these reports. Ultimately, there is no way to know the true rate of app adherence in the current study, and a common issue inherent in studies such as this one is overreporting of app usage (Christen et al., 2009).

Retention is another issue that may have impacted the results of the current study. At the end of the 6-week intervention, each condition had retained only 1/3 of the participants. Overall, the attrition rate in this study was 69%, which is approximately 19% greater than the high-end of what is typically seen in randomized control trials of internet-delivered interventions. The reasons for the higher rates of attrition in the current study are unclear, though some reasonable assumptions can be made. Students were likely drawn to this study by the incentives offered, however, once enrolled, they were not required to complete the study in order to benefit from these incentives. Attrition may have also been impacted by academic workload, as would be expected in a student population. Additionally, the current study took place over the course of the COVID-19 pandemic which may have impacted students' ability to take on additional pursuits; though one would think that the impact of this unprecedented event would have motivated students to participate in stress reducing endeavours.

App Adherence and Study Completion

Among those who completed the current study, there were no differences in levels of psychological anxious and depressive distress between participants who complied with app adherence, and those who did not. There was, however, a difference between those who completed the study and those who did not, with those who dropped out having significantly higher levels of psychological anxious and depressive distress. This finding seems rather counterintuitive as one would expect people to seek help when they are experiencing high levels of psychological distress. However, there is research to suggest that individuals experiencing mild to moderate psychological distress have a high dropout rate from therapeutic interventions (Fernández et al., 2020).

More positively, among those who completed the study, a trend was observed across the 6-weeks in relation to using the assigned app to help deal with difficult situations. Every two weeks, approximately 76% of participants reported experiencing a stressful situation, and approximately 55% of those participants reported using their assigned app to help them cope. This trend was also observed among the participants who dropped out as the study went on. This appears to be one of the more promising findings of the current study as more than half of the participants utilized a mental health resource that was readily available to them without prompting. This finding could potentially bode well for the successful uptake of mHealth apps among university students experiencing acute psychological distress.

Reliability of Self-Reported Psychological Distress in University Students

The mental health information provided by the participants of the current study calls into question the validity of self-reported psychological distress among university students, particularly in relation to depressive distress. Based on participant responses to open-ended

mental health queries on the baseline demographic questionnaire, self-identified symptoms of psychological depressive distress were endorsed by 41.6% of those who completed the study. However, when objectively assessed through the HADS, only 20.7% of the participants were classified as demonstrating depressive distress. This could suggest that the participants who subjectively reported experiencing psychological depressive distress did not have a full understanding of symptomatic depression, or they catastrophized their level of angst. However, this is not surprising given that people are often biased when they report on their own experiences.

Conversely, participants in the current study appeared to underreport symptoms of psychological anxious distress on the open-ended demographic questionnaire. On this form, 46.8% of students self-identified anxious distress, compared to 59.7% identified through objective assessment on the HADS. While it appears that the participants may have overreported, or catastrophized their feelings of psychological depressive distress, it seems as though they underestimated their levels of psychological anxious distress.

The difficulties encountered with self-reporting of psychological distress in the current study brings us full circle to the issues previously identified regarding student mental health terminology in the literature. This calls attention to the fact that researchers are attempting to measure the same "constructs" (i.e., "anxiety", "depression") using different theoretical frameworks, different definitions, and different evaluation methods. It is no wonder then, that there is an overabundance of mental health terminology in the literature, along with variations in prevalence rates.

Similarities with Previous Research

Despite variations in reported prevalence rates, the most common findings among university students are high rates of anxious and depressive distress (Adlaf et al, 2001; Ontario University & College Health Association [OUCHA], 2017; Robinson et al., 2016; Sharp & Theiler, 2018; Youth Mental Health Stats in Canada, 2019). The results of the current study support these findings and also provide support for the finding that university tends to provoke anxious distress to a greater extent than depressive distress (Andrews & Wilding, 2004; Cooke et al., 2006).

Another outcome of the current study that is consistent with previous research among university students is the predominance of female participants. The current sample was 76.6% female, which like other research with predominantly female participants, could limit the generalizability of the results. This tendency could indicate a greater interest and willingness among women to take part in well-being studies. Alternatively, it could support previous research suggesting that females tend to have higher levels of mental health issues than males (McLafferty et al., 2017), along with higher rates of help-seeking behaviour (McCloud et al., 2020).

The app adherence rate in the current study is also comparable with previous studies evaluating mHealth apps, particularly where therapist contact or direct oversight is absent (McCloud et al., 2020; Christensen et al., 2009; Clarke et al., 2002). Furthermore, as previously mentioned, retention was another problematic issue in the current study that is consistent with previous research.

Implications for the Utility of mHealth Apps

While the current study did not find support for the efficacy of mHealth apps in university students, there are potential glimmers of hope for this form of mental health intervention. In support of this treatment modality, 35% of the participants in the current study previously used an app of any kind to help with their emotional state, and 96% found the app helpful. More promising still, most of the previous apps used by participants were mental health apps. Furthermore, as previously stated, more than half of the participants in the current study used their assigned mHealth app without prompting to cope with an acute stressor. This finding potentially provides support for the use of mHealth apps among university students.

Perhaps one of the more problematic issues associated with mHealth apps and internet-based interventions in general, is the significant emphasis and confidence placed on these modalities as inevitable future forward mental health care, particularly in the youth sector. The funding and enthusiasm put towards expanding these new treatment modalities, particularly from governments, is likely to reduce financial support for publicly funded in-person mental health care. This is concerning given that mental health app design is very much in its infancy (Weisel et., 2019). Furthermore, while people undoubtedly rely on their technological devices to help with many aspects of their lives, there is indication that in-person interventions are still preferred. For example, in the current study, participants who had engaged in counselling, and had also used an app to help with their emotional state, expressed a preference for professional counselling. Other research has found that students have expressed concerns about mobile apps being used as a replacement for in-person therapy, as students are more interested and willing to use apps as a service integrated with in-person work (Levin et al., 2017). As such, over-reliance

on internet delivered mental health care could potentially have a negative impact on the emotional well-being of those it is intended to help.

Strengths and Limitations of the Present Study

Strengths

As one of the few randomized controlled trials (RCT) of its kind, the present study makes a useful contribution to the literature by comparing three stand-alone mHealth apps with an active smartphone-based control condition. Moreover, attempts were made to avoid methodological issues common throughout the internet-based mental health literature by clearly defining app adherence. Furthermore, the apps were offered to users as they would be in a real-world setting and without supervision, with the intention of contributing to a higher level of external validity. Additionally, the online self-administration of all outcome measures eliminated observer bias.

Limitations

One of the main limitations of the current study was attrition, as only 31% of participants completed the full six weeks of the study. However, this rate is comparable with previous studies using mobile and internet technologies. Similarly, app adherence in the current study was disappointing despite attempted reduction strategies. Another important limitation of this study was the inclusion of participants who did not report pre-treatment anxious and depressive distress on the HADS, which limited the ability to detect discernible change in levels of psychological distress, which may have impacted the power to detect expected effects. Unfortunately, given the confines of the current study, including availability of participants and time limits, it was not possible to exclude students in order to acquire an ideal "clinical" sample. Additionally, the requested app usage schedule was admittedly low, at once per week. This may

have impacted the efficacy of the mHealth apps due to limited intervention. It was also not possible to monitor or confirm the self-reported app usage of the participants, and they may have actually overreported their usage.

An additional limitation of the current study involved the predominance of female participants, which could limit the generalizability of the results. Likewise, since the sample consisted of university students, the results of this study may not be generalizable beyond this population. As well, given the small sample size, the results of this study should be interpreted with caution. It is also not known if any of the participants decided to pay for in-app purchases that may have impacted their user experience. Lastly, the sudden removal of the Stresscoach app from the Canadian app market affected the randomization of participants across the apps. This may have impacted the ability to properly evaluate the efficacy of the Stresscoach app in reducing symptoms of anxiety and depression.

Future Directions

Future research on the efficacy of mHealth apps should screen participants and exclude those who are not reporting psychological distress in order to build a sample of participants who are considered "clinical" and who can demonstrate change with interventions. Future research with university students should also consider using a mental health measure that takes into account issues relevant to this population in an attempt to more accurately measure pertinent psychological distress.

Attempts should also be made to identify the reasons for high rates of attrition, particularly among university students in order to help guide the future development of mHealth apps geared towards this population. Furthermore, future web-based trials should request more frequent use of the apps being studied in order to more effectively measure the apps utility.

Incorporating some elements of interaction with participants may improve app adherence and participant retention, such as through in-person consent procedures, demonstration of the apps, and/or regular personalized reminders to use the apps, which has also been suggested by McCloud and colleagues (2020). However, this approach could impact anonymity and confidentiality and potentially deter participants. It may also be useful to obtain detailed information related to other mental health interventions, potentially including pharmacological treatments, that participants may be engaging with during the research trial.

Future research would benefit from more detailed and reliable data on participants' usage and experience with the apps, potentially including qualitative feedback on perceived usefulness, as also recommended by McCloud and colleagues (2020). Furthermore, direct monitoring of participants' app usage through access to app metrics would provide more reliable information related to app adherence. It would also be prudent to use a community sample as a comparison group as this research approach has been lacking in previous studies. Future research should also consider incorporating an active smartphone-based control group, as was done in the current study, to control for the digital placebo effect, which is an interesting phenomenon worthy of further investigation. Lastly, future research should make attempts to recruit participants from multiple universities to ensure larger sample size and greater diversity.

Conclusions

While mobile mental health apps (mHealth) are proliferating in the app market and are seen as a new and promising treatment option for people with mental health challenges, they are an under-researched treatment modality, and should be treated as such. While they have the potential to reach more people in more places, the evidence for their utility is lacking. The current study attempted to explore the effectiveness of this treatment modality among university

students, a population that is known to experience high levels of psychological anxious and depressive distress. Unfortunately, this study did not find evidence to support the efficacy of mHealth apps as a short-term intervention to help students experiencing this type of distress. The current study did, however, find that the passage of time, in and of itself, resulted in a change in levels of psychological anxious distress, with those at the higher end of anxious distress experiencing a decrease, and those at the lower end experiencing an increase. There was also a potential increase in levels of psychological depressive distress among those at the lowest distress level. Further research is needed to replicate this study design with larger samples to help evaluate the utility of mHealth apps in general, and more specifically among high needs populations, such as university students.

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Appendices

Appendix A: Demographic Questionnaire

Please answer the following to the best of your ability. If you aren't sure of your response, or don't wish to respond, please indicate "I don't know," or leave the question blank.

All information is confidential, and your name will not be associated with this questionnaire.

1. Which University do you attend? _____
2. What is your age? _____
3. How would you describe your gender identity? _____
4. What is your program of post-secondary study? _____
5. What year of study are you in? _____
6. Are you a full-time ( ) or part-time student ( )?
7. Have you ever struggled with mental health issues?
   Yes ( ) No ( ) Would rather not say ( )

   If yes, would you mind sharing? (i.e., anxiety, depression)_____

8. Have you ever used a mobile app to help with your mood, feelings, or emotions?
   Yes ( ) No ( ) Would rather not say ( )

   If yes, do you know the name of the app? _____, and did you find it

   helpful? Yes ( ) No ( )

9. Are you currently seeing a counsellor, therapist, or social worker for professional
   counselling to help with your mood, feelings, or emotions?
   Yes ( ) No ( ) Would rather not say ( )

   If yes, please indicate if it is in-person ( ) or virtually ( )

10. If you have engaged in professional counselling (past or present) **and** have also used a
    mobile app to help with mood, feelings, or emotions, did you find professional
    counselling to be more effective than the app in addressing your difficulties?
    Yes ( ) No ( ) Does not apply to me ( )

    <u>*OR*</u>

    ( ) They were both effective

    ( ) Neither was effective

    Regardless of outcome, which did you prefer?

    ( ) Formal counselling

    ( ) Using an app

Appendix B: App Usage Questionnaire for Week 2

As part of participating in this study, you were asked to keep track of your usage of the app assigned to you. To the best of your ability, please answer the following questions based on the last two weeks:

1. What is the name of the app that you were assigned to? _____

2. Please indicate how often you used your assigned app in <u>the first week</u> of this study:

    ☐ Not at all   ☐ Once   ☐ Twice   ☐ More than three times

3. Please indicate how often you used your assigned app in <u>the second week</u> of this study:

    ☐ Not at all   ☐ Once   ☐ Twice   ☐ More than three times

4. Have you experienced a particularly stressful situation(s) in the last two weeks?

    Yes ☐   No ☐

    If yes, did you use the app to help you cope with the situation(s)?

    Yes ☐   No ☐

Appendix C: App Usage Questionnaire for Week 4

As part of participating in this study, you were asked to keep track of your usage of the app assigned to you. To the best of your ability, please answer the following questions based on the last two weeks:

1. What is the name of the app that you were assigned to? _____

2. Please indicate how often you used your assigned app in <u>the third week</u> of this study:

    ☐ Not at all   ☐ Once   ☐ Twice   ☐ More than three times

3. Please indicate how often you used your assigned app in <u>the fourth week</u> of this study:

    ☐ Not at all   ☐ Once   ☐ Twice   ☐ More than three times

4. Have you experienced a particularly stressful situation(s) in the last two weeks?

    Yes ☐   No ☐

    If yes, did you use the app to help you cope with the situation(s)?

    Yes ☐   No ☐

Appendix D: App Usage Questionnaire for Week 6

As part of participating in this study, you were asked to keep track of your usage of the app assigned to you. To the best of your ability, please answer the following questions based on the last two weeks:

1. What is the name of the app that you were assigned to? _____

2. Please indicate how often you used your assigned app in <u>the fifth week</u> of this study:

    ☐ Not at all ☐ Once ☐ Twice ☐ More than three times

3. Please indicate how often you used your assigned app in <u>the sixth week</u> of this study:

    ☐ Not at all ☐ Once ☐ Twice ☐ More than three times

4. Have you experienced a particularly stressful situation(s) in the last two weeks?

    Yes ☐ No ☐

    If yes, did you use the app to help you cope with the situation(s)?

    Yes ☐ No ☐

Appendix E: Ethics Approval

APPROVAL FOR CONDUCTING RESEARCH INVOLVING HUMAN SUBJECTS
Research Ethics Board – Laurentian University

This letter confirms that the research project identified below has successfully passed the ethics review by the Laurentian University Research Ethics Board (REB). Your ethics approval date, other milestone dates, and any special conditions for your project are indicated below.

TYPE OF APPROVAL / New / Modifications to project **X** / Time extension	
Name of Principal Investigator and school/department	Jennifer Dufoe, Psychology MA program, Supervisor Elizabeth Levin
Title of Project	The Impact of Mobile Applications on the Mood of University Students
REB file number	6020999
Date of original approval of project	June 17th, 2021
Date of approval of project modifications or extension (if applicable)	July 14, 2021
Final/Interim report due on: (You may request an extension)	June 17th, 2022
Conditions placed on project	

During the course of your research, no deviations from, or changes to, the protocol, recruitment or consent forms may be initiated without prior written approval from the REB. If you wish to modify your research project, please refer to the Research Ethics website to complete the appropriate REB form.

All projects must submit a report to REB at least once per year. If involvement with human participants continues for longer than one year (e.g. you have not completed the objectives of the study and have not yet terminated contact with the participants, except for feedback of final results to participants), you must request an extension using the appropriate LU REB form. In all cases, please ensure that your research complies with Tri-Council Policy Statement (TCPS). Also please quote your REB file number on all future correspondence with the REB office.

Congratulations and best wishes in conducting your research.

Rosanna Langer, PHD, Chair, *Laurentian University Research Ethics Board*